Front Cover

The laminated phenolic plastic, Micarta, is made in the Trafford, Pa., plant of the Westinghouse Electric & Manufacturing Co. In tanks like these volatilized solvents from treating towers are recovered and fed back into production as raw materials. Other pictures will be found in the pictured flowsheet on pp. 183–186.

Next Month

With the April issue *Chem. & Met.* will inaugurate a third series of Chemical Engineering Reports. They will deal with the opportunities for chemical engineers in various process industries—the jobs they hold, kinds of work they do and future prospects regarding number employed by the industry. In April we shall present "Opportunities in the Pulp and Paper Industry."

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MARCH, 1940

S. D. KIRKPATRICK, *Editor*

For Engineering Executives

LAST MONTH an interested chemical audience in New York listened to a unique debate for which we have suggested the slightly misleading title of "Executive vs. Technologist." American Cyanamid's able president presented a convincing case for the non-technical administrator by showing how many of modern industry's demands are for financial, legal and purely business talents. He did this without in any way underestimating the value of research; in fact Mr. Bell made an eloquent appeal for better understanding of science on the part of all executives. Then, Dr. E. C. Williams, vice-president of the Shell Development Co., after defining technologists as the creative forces of industry, proved that they could make their most effective contribution only under highly intelligent and sympathetic management. What started as a debate and did exhibit some striking differences of opinions on details and procedures, finally ended on a note of unity in mutual respect and understanding.

In the early days of chemical industry, as Mr. Bell pointed out, it was not difficult to bring the executive and technologist together—physically as well as mentally. They were often one and the same man. It was only when we started multiplying management that we began dividing authority. Perhaps we have gone too far in that process of specialization of talents and disciplines. By substituting committees and department heads for the driving force of the big boss, we may have lost some of the intimate knowledge and sympathetic understanding that are so desirable.

In any organization where such conditions exist, the trend should be toward bringing more technically trained men into the important executive positions. This is especially true in chemical industry where the financial and legal problems are relatively secondary to the main functions of developing, producing and distributing goods. To quote another Cyanamid executive, who was for years its chief technologist, "We do not legislate a process out of the laboratory or sue it through the operating unit. No court decree will make a reaction run up hill against a free energy equation." Bankers, although money-minded, are usually "not familiar with (chemical) costs, with adequacy of (equipment) design, with sales and distribution of goods which control working capital needs."

We believe, as Dr. W. S. Landis recently told the American Institute of Chemists, that our future executives will generally come from those groups with engineering training. "I have reached the conclusion," he said, "that the youngster intending to enter the chemical industry and with the intention of going somewhere in it, should have an engineering education, preferably with a knowledge of chemistry and, naturally, although not absolutely necessary, a chemical engineering training."

Indications are that progress is being made in this direction. For instance, Dr. Karl T. Compton has shown in his survey of American corporations that the engineer is twelve times more likely to become president of his company than is the non-engineer, five times more likely to become its treasurer and thirty times more likely to become an executive officer. And he has also said that, "An engineer differs from the technologist in that he must concern himself with the organizational, economic and managerial as well as the purely technical aspects of his work." So it would seem that as time goes on, there will be fewer occasions to debate the differences between executives and technologists and more occasions to note the results of unity of thought and purpose among our engineering executives.

From an

OUR MODERN PIONEERS

Chemists, engineers, inventors and research workers by the hundreds graced the banquet boards of more than a dozen cities throughout the United States last month. The occasion was to celebrate the 150th anniversary of the fonding of the American patent system and to bring home to our people the great peace-time achievements that have resulted from it. The National Association of Manufacturers sponsored this Modern Pioneers program to show that there are new frontiers in America which hold promise of greater wealth, more goods, more jobs, and higher standards of living than were ever produced by those who pushed back the geographical frontiers of the prairies and mountains.

We may well be proud of the fact that almost a third of the men who were selected by Dr. Compton's committee of eminent scientists were representatives of the chemical and process industries. Of the nineteen national awards, twelve were made to outstanding chemists and chemical engineers,—such men as Baekeland, Cottrell, Curme, Dorr, and Langmuir. Significantly, the 19th went to du Pont's nylon research group headed by the late Dr. Wallace H. Carothers. Of more than 500 local awards, approximately 150 represented chemical engineering industries.

Chem. & Met. extends congratulations to all who were thus honored. Their contributions are already well known to our profession. They are not as well known to the public at large, however, and it is to that larger and perhaps more influential audience that this program had its major appeal. Politicians in the future will think twice before they attack an institution that is so fundamental to indusrial progress as is the American Patent System.

VITAL INDUSTRIAL MINERALS

Nonmetallic minerals are among the most important of chemical raw materials. This fact has been conspicuously demonstrated in a series of lectures which have been prepared by some of the senior specialists of the U. S. Bureau of Mines and delivered under the auspices of the University of Maryland at College Park. These discussions have paraded anew many important facts vaguely known but too little noticed by chemical engineers.

Beneficiation remains an area of industrial activity which has not been adequately served by miner, metallurgist, or chemical engineer. This is by no means a virgin field for research or technical development, but it is none the less an extremely important one. Many process industries are taking what the miner produces with little preparation. And few miners of nonmetallics have adequately studied the real customer need.

Many of our manufacturers of heavy chemicals might do well to explore the possibilities of new work in this area of industrial minerals. In some cases they will find that their own chemicals may usefully be applied in the processing or preparation of the raw mineral to make it more valuable to the using industry. In other cases they will find that the miner can do the processing but that he does not have the facilities for effective distribution. Often the distributor of chemicals is in a better position to take these minerals to the user along with the heavy chemicals which are also purchased for simultaneous use.

It is perhaps dangerous to generalize too widely on this subject. But it does appear safe to say that market studies, potential new uses and the possibilities of preparation in higher purity or more usable form are all phases of the subject worthy of chemical engineering review. At a time when every important company is seeking to broaden its field of activity with new lines of effort which fit logically in with the old, this preparation and marketing of industrial minerals certainly deserves executive attention.

PROFESSIONAL ZEALOTS

Members of certain engineering societies engaged in professional work either in New York or adjacent states, and who are not licensed to practice engineering in the State of New York, have recently received a disturbing communication from the president of the New York State Society of Professional Engineers. He has warned that the presence of their names on the membership lists of these societies constituted a violation of Section 1450 of the New York Education Law which relates to the use of the title of engineer by other than licensed persons.

Chemical engineers will be pleased to learn that this letter was not issued with the authorization or approval of the State Department of Education. As

Editorial Viewpoint

a matter of fact, Mr. S. L. Tyler, A.I.Ch.E. secretary, has been informed by Associate Commissioner Milton E. Loomis as follows:

> It is the interpretation of the Department, supported by the interpretation of the Attorney General, that the Act did not intend to and, in fact, does not prohibit membership in professional societies on the part of unlicensed engineers, and that the presence of the names of such persons on any membership list is in no way a violation of the law. I am confident that in practically every instance unlicensed persons who are members of your bodies are engaged in a form of practice either in connection with public or private corporations or otherwise which does not require licensure under the law, and that, therefore, no action of any kind will lie against them.

This is a most encouraging and constructive attitude, especially so because it comes at a time when the Senate of the State of New York has before it a bill to make additional amendments to the Education Law with respect to the practice of professional chemists. Even the most ardent proponent of licensing must admit that the administration of the statue should remain in official hands.

COLLEGE CONTROL OF PATENTS

Numerous educational institutions are undertaking to participate with their faculty people in securing the control of patents resulting from research done in their engineering schools. The surprising extent to which this idea has developed is made clear by a summary presented at the Christmas meeting of the American Association for Advancement of Science by Dean A. A. Potter of Purdue. He has very helpfully summarized the forms of contract and control arrangement which various schools are undertaking to establish.

Industries seeking to cooperate with educational institutions or their faculty members must take account of this development. Apparently it is no longer practical for industry to use indiscriminately the consulting services of faculty men in cases where a patentable invention may result. At those schools where an attempt is made to have the institution control such inventions, it will require some care to be sure that proper arrangements are made with valuable faculty consultants in order to avoid serious misunderstanding between industry and the institutions involved.

It may often be desirable to have the stabilizing influence of the educational institutions surrounding invention and patent policies of faculty men. This will often assist in the proper and desirable development of patents which the individual professor might not be able or wish to develop himself. But it is sincerely to be desired that the educational institutions do not go too far in their effort to assist. If they do, they may find that they actually interfere, perhaps unintentionally, but none the less seriously, with the desirable constructive cooperation between industrial research groups and faculty men capable of contributing consultation or research assistance.

Most important of all will be a clear understanding at the beginning regarding the relationships which are to prevail whenever industry seeks or accepts cooperation with educational institutions or their faculty men. Good sense and fair dealing must prevail or all parties may be embarrassed,—even suffer financial loss.

TRAIL OF THE FORTY-NINERS

Each year the annual report which President Queeny presents to the stockholders of Monsanto Chemical Co., usually provides us with the text for a "guest editorial." This year's is no exception. Seldom have we seen a better statement than his of the necessity for continuous research to improve old products or to find new ones:

> Like the Trail of the Forty-niners, the path of the chemical industry is strewn with the bones of dead products and processes. Here is a bleached skull that was the natural dye industry, here is a shin-bone which had been charcoal iron manufacture, and there an old battered covered wagon which used to be the LeBlanc soda-ash process. Our industry lives in the shadow of obsolescence; our investment and position can be made secure only by unremitting attention to improving our manufacture either by bettering our processes, devising new ones, or inventing new products to give better service than the old.

When all executives and stockholders view research and development in this light, adequate appropriations and enthusiastic support are assured.

New Acetic Anhydride Process

Although in commercial operation for several years, the Shawinigan process for making acetic anhydride from acetaldehyde has never been described in the technical literature. It has, however, proved to be a major source of this important raw material.

General view at the Chemicals Division of Shawinigan Chemicals, Ltd. where acetic anhydride is produced. A carbide plant is in the background

G. BENSON
Assistant Director of Plant Research
Shawinigan Chemicals, Ltd.
Shawinigan Falls, P. Q.

An account of the processes being conducted by Shawinigan Chemicals, Ltd., appeared in *Chem. & Met.* in 1931[1]. Since then there has been put into operation a new process for the manufacture of acetic anhydride of which, outside the patent literature[2], there has been only brief mention in print[3], and it would seem that an outline of the development of the process would be of interest.

During the last twenty years there has been a steadily increasing demand for acetic anhydride[4], chiefly for the manufacture of cellulose acetate. The methods usually employed for the production of anhydride depend on the dehydration of acetic acid either by such materials as sulphuryl chloride or by catalytic cracking, from ethylidene diacetate, for which the raw materials are acetylene and acetic acid, and from ketene, in which acetone is the raw material.

One of the chief products made by Shawinigan Chemicals, Ltd., is acetic acid from the oxidation of acetaldehyde. The mechanism of this oxidation has been studied in many laboratories. It is agreed that although the equation (1) may correctly represent the end products it does not give a true picture of the course of the reaction which is more correctly represented by the two equations (2) and (3) which show the intermediate formation of peracetic acid.

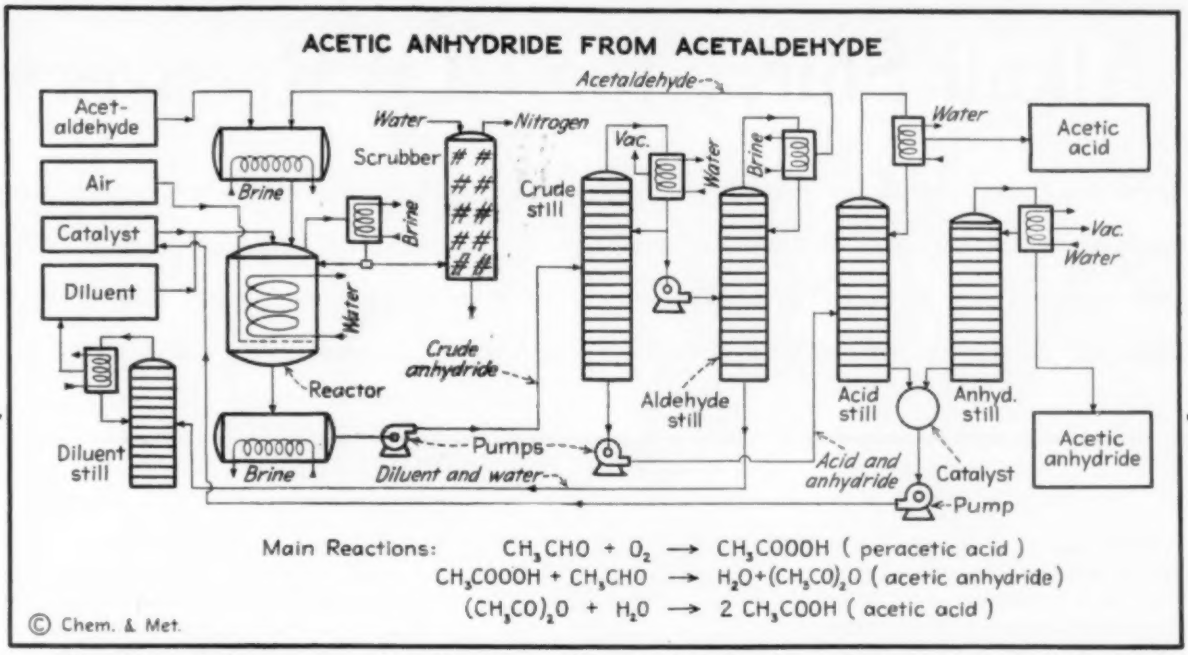
$$2CH_3CHO + O_2 \rightarrow 2CH_3COOH \quad (1)$$
$$CH_3CHO + O_2 \rightarrow CH_3COOOH \quad (2)$$
$$CH_3COOOH + CH_3CHO \rightarrow 2CH_3COOH \quad (3)$$

The above scheme has been elaborated to fit in with certain experimental facts, but incomplete as it may be, it was sufficient to point the way to the successful commercial preparation of acetic acid by the oxidation of acetaldehyde with air or oxygen, the first patent being issued in 1908[5]. Since the peracetic acid appeared to be an explosive material, its concentration had to be kept down by increasing the rate of the reaction represented by equation (3). This is done by using a high temperature and by the use of certain salts as catalysts, particularly, the acetates of cobalt or manganese. Certain chemical engineering difficulties are involved which were successfully solved by H. W. Matheson[6] enabling acetic acid to be produced on a large scale at Shawinigan Falls during the first World War. When a batch process is employed, a small proportion of catalyst is added to acetaldehyde and air is bubbled through. The mixture is at first colorless when manganous acetate is employed as a catalyst but as oxygen is absorbed the manganese is oxidized to a higher valence and the liquid becomes brown. While the oxygen is being absorbed from the air it is safe to increase the pressure and temperature. Pressures employed are usually around 60 lb. per sq. in. and temperatures of 50 to 70 deg. C. The progress of the oxidation can be followed by titrating the mixture for acetic acid and it can be carried on until less than one per cent of the acetaldehyde is left unoxidized. It was the study of apparently unimportant peculiarities in this titration of acetic acid during the oxidation which led to the discovery that there were present varying amounts of acetic anhydride. This acetic anhydride is necessarily accompanied by its equivalent of water which will combine with it rapidly, so that no anhydride is actually obtained by the normal method of distillation of the crude acid.

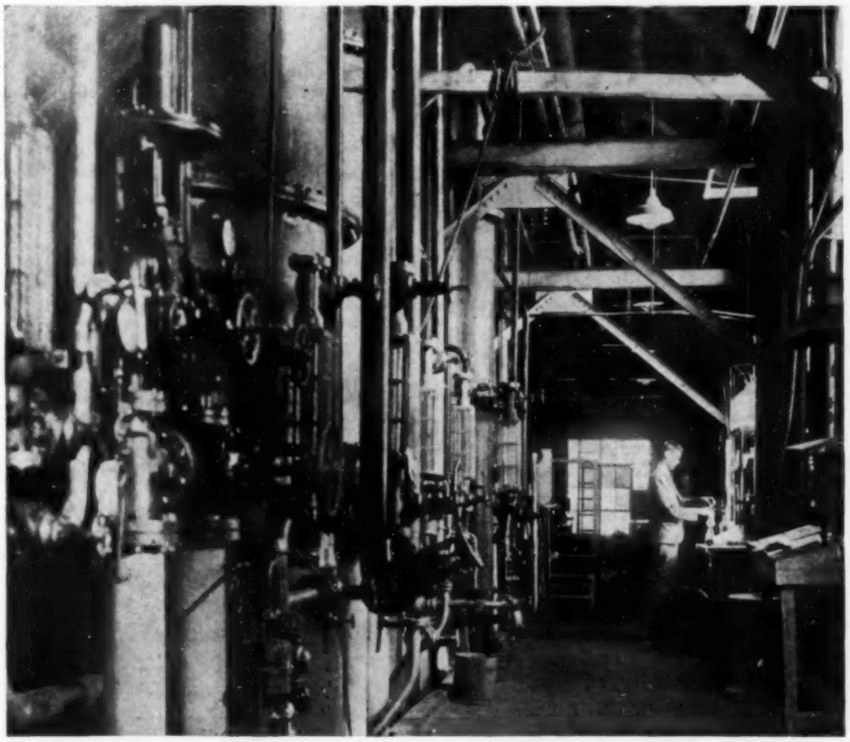
Study of the reaction showed that the formation of the anhydride occurred as an intermediate in the formation of the acid although acid formation could occur without intermediate anhydride formation, that is, that there are two parallel reactions which can most simply be represented as follows:

$$CH_3COOOH + CH_3CHO \rightarrow 2CH_3COOH \quad (4)$$
$$CH_3COOH + CH_3CHO \rightarrow (CH_3CO)_2 + H_2O \quad (5)$$
$$(CH_3CO)_2O + H_2O \rightarrow 2CH_3COOH \quad (6)$$

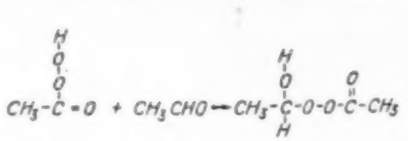
In order to increase the yield of acetic anhydride it is necessary to make the reaction proceed by (5) and to cut down the loss of anhydride by preventing or reducing the amount of the reaction represented by (6). The first objective was attained by variation in the catalyst used; the second by reducing the temperature and increasing the speed of the oxidation. These changes, however, are limited by the fact that they also tend to increase the concentration of the dangerous peracetic acid. A third expedient was to conduct the oxidation in a diluent which would cut down the rate of reaction (6)[7]. By these means



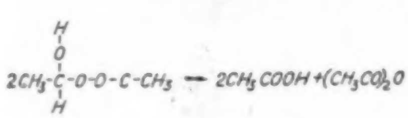
Flow sheet of the process used at Shawinigan Chemicals, Ltd. for the production of acetic anhydride



Anhydride still house, an interior view showing part of the control floor



Aldehyde hydrate peracetate



it is possible to obtain in the final product a greater weight of acetic anhydride than of acetic acid. This result disproves the mechanism (shown at the left) which was suggested by Rieche[8] by which it would be impossible to obtain acetic anhydride and acetic acid in a ratio higher than 102/120.

In order to obtain acetic anhydride from the crude oxidation product the water must be removed as soon as possible after the oxidation is completed, any intermediate storage of the crude being conducted at a low temperature. The water removal can be accomplished by dehydration with a substance such as anhydrous calcium sulphate which can then be followed by a simple fractionation of the dehydrated mixture, or the removal of water and separation of the other products can be brought about simultaneously by distillation. It is the second method which is now being used at Shawinigan, a flow sheet of the process being given in the diagram.

Essentially the equipment consists of a reactor in which the acetaldehyde is oxidized by air in the presence of a diluent and a catalyst. Then separation of the reaction products is accomplished in a number of bubble-column stills pictured in the accompanying illustration. Note that the crude still and the anhydride still operate under vacuum.

In contradiction to the adage of "seven years from test-tube to tank car," within two years of the laboratory preparation of acetic anhydride by the above method, a plant with a monthly capacity of one million pounds of acetic anhydride was put into operation.

References

[1] Cadenhead, *Chem. & Met.* **40**, 184 (1933).
[2] Brit. Pat. No. 446,259.
[3] *Chem. Trade Journal,* 21 Aug. and 4 Sept. 1936.
[4] *Chem. & Met.* **46**, 118 (1939).
[5] D. R. Patent No. 223,208.
[6] Matheson, Brit. Pat. No. 132,558.
[7] Brit. Pat. No. 461,808.
[8] Rieche, *Ang. Chem.* **51**, 707-9 (1938).

Alkali Slurry for CO_2 Recovery

Interesting possibilities for greatly increasing the efficiency of carbon dioxide recovery from flue gases for use in the manufacture of liquid and solid carbon dioxide are envisioned by the author through the use of a new process which employs as the absorbent a slurry of saturated alkali carbonate containing solid bicarbonate.

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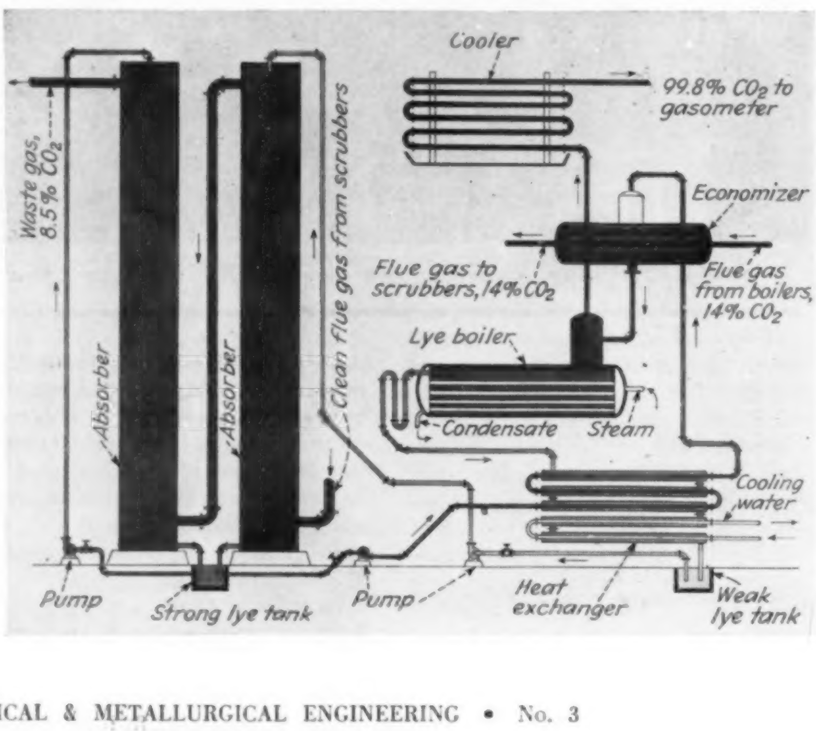
INCREASING use of solid carbon dioxide is focusing the attention of users and producers upon lower cost of manufacture, as well as upon methods suitable for localities where the conditions up to the present have not been propitious for manufacturing this commodity. In an article published several years ago by the author (*Chem. & Met.* Mar. 1931, p. 136ff.) the derivation of CO_2 is stated to be from raw materials such as the fermentation of saccharine materials, molasses and grain, and from natural sources, such as natural gas wells; but the largest amount of CO_2 is recovered from lime kilns and flue gases produced by burning a high grade of coke. Carbon dioxide from fermentation products and natural sources requires only deodorization, since the CO_2 content is high, 90-99.8 per cent. However, CO_2 in flue gases from coke or lime kilns varies from 17-40 per cent, and as these gases are contaminated with dust, sulphur dioxide and hydrogen sulphide, to use them requires more complicated treatment before the CO_2 can be liquefied.

The present article discusses a new process developed by the author for concentrating CO_2 from flue gases, but before describing it in detail, a brief resumé of other processes will not be amiss. Present-day chemical concentration processes are based upon the fact that certain inorganic compounds such as alkali carbonates (sodium or potassium) and the organic bases, mono- and triethanolamine, developed by the Girdler Corp. (the Girbotol Process), are capable at suitable temperature of removing acidic gases such as CO_2 from flue gases. Then, upon heating above 212 deg. F., the absorbed CO_2 is liberated and the absorbent used is regenerated for use over and over again. Thus a complete cycle is achieved and when proper precautions are taken for the removal of impurities such as dust, sulphur dioxide and hydrogen sulphide, before the flue gas comes in contact with the absorbent chemical, the loss of the absorbent is negligible. Instead of a single chemical, D. H. Killeffer, describing the Macmar process (*Ind. Eng. Chem.*, ***29***, June 1937), calls attention to excellent results obtained by using a combination of an alkali carbonate with ammonia.

Up to the present the most extensively used process in North America has been the so-called standard absorption process. According to this process (*Chem. & Met.*, Mar. 1931, p. 136ff.) a plant producing 1 ton (2,000 lb.) of liquid CO_2 per hour requires approximately 0.85-1.25 tons of a high grade coke. The flue gas after being freed of its impurities passes into a series of coke-packed absorption towers, 10 ft. in diameter and 100 ft. high, over which an alkali carbonate solution or "lye" is circulated. The flue gas enters the bottom of the absorbers while the absorbent "lye," either sodium carbonate, potassium carbonate or a combination of the two, is circulated countercurrent to the gas. The flue gas entering the towers generally contains 17 per cent CO_2 and the waste gas, 8-9 per cent. Thus 50 per cent or even more of the CO_2 is lost. Four large absorbers are used and usually two are in series.

Fig. 1—Standard absorption process for recovery and concentration of carbon dioxide from flue gases. (Note: A 17-per cent carbon dioxide is preferable)



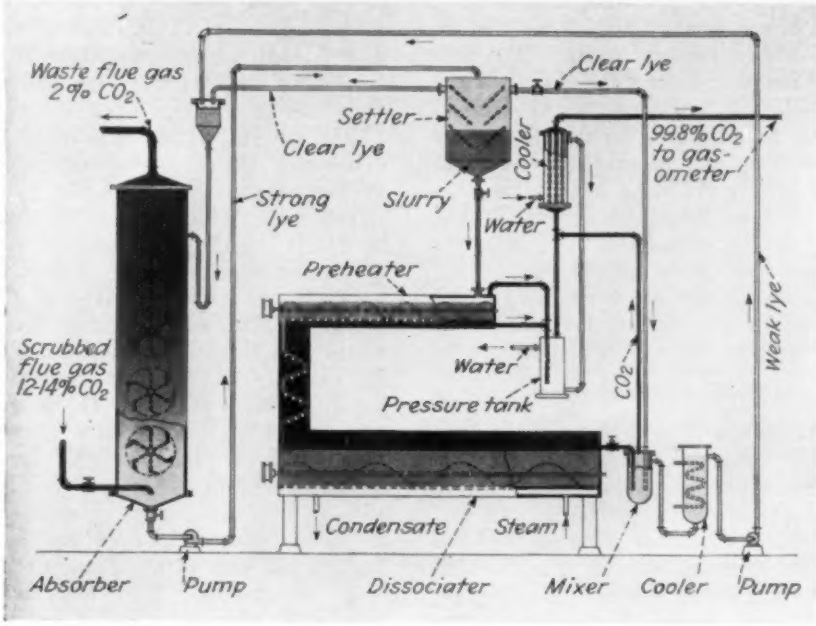
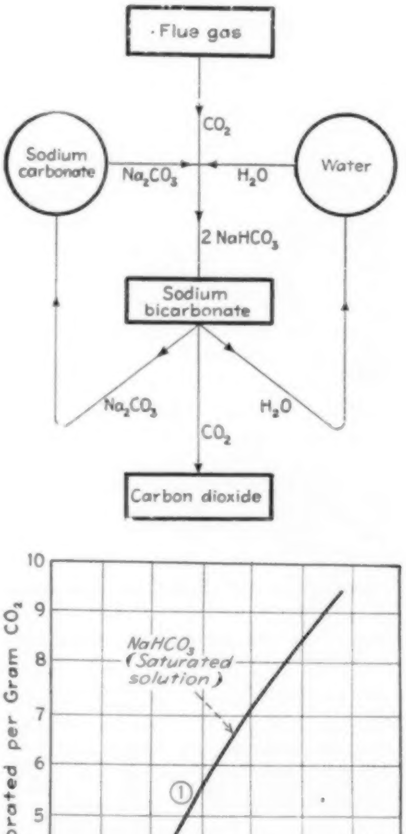


Fig. 4.—Reich absorption process for recovery and concentration of carbon dioxide from flue gases



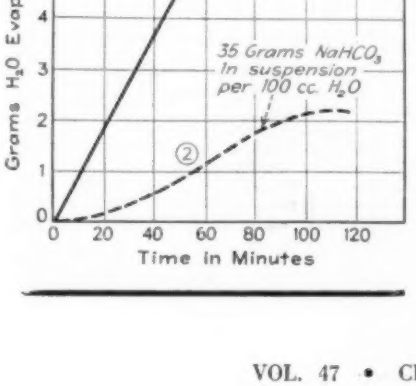


Fig. 2—How the standard absorption reaction operates

Fig. 3—Evaporation of water from saturated carbonate solutions and bicarbonate slurries

During the passage of the flue gas through the absorbers the alkali carbonate is converted into alkali bicarbonate and this liquid passes through a lye boiler, where the alkali bicarbonate is dissociated, liberating CO_2 and regenerating the carbonate. After cooling, the gas is collected in a gasometer, while the hot lye, now called "weak lye" because of its loss of CO_2, is cooled to a temperature of approximately 120 deg. F. by heating the "strong lye" from the absorbers and is returned to the absorption towers for reabsorbing purposes. Fig. 1 shows diagrammatically the cycle of the standard absorption process except for the scrubbers in which the flue gas is freed of its impurities.

The chemical reaction which takes place in the absorption system can be expressed as shown in Fig. 2. The CO_2 in the flue gas first combines with the alkali carbonate and water. Then, upon heating, CO_2 escapes while the water remaining with the alkali carbonate is recycled. The carbonation liquid, containing 7 to 8 lb. of sodium carbonate per cubic foot of solution, or an average of 1 lb. per gallon of liquid, is not saturated and has a specific gravity of 1.1045-1.1185 (13.7-15.3 deg. Bé.). If all the sodium carbonate were converted into bicarbonate, still the liquid would not be saturated. However, in the standard process only 50-60 per cent of the sodium carbonate is converted into sodium bicarbonate and after passing through the lye boiler it still contains 30-40 per cent of the sodium carbonate as bicarbonate. Therefore, in order to produce 1 lb. of CO_2 the process requires approximately 12 gal. of "strong lye". Quinn & Jones, in their book, "Carbon Dioxide," state on page 168 that "Most plants are designed so that not more than 20 to 25 per cent of the lye flowing through the coke tower is diverted through the lye boiler." Thus the absorbing lye passes through the absorber about four to five times for each passage through the "desorber". They further state that 2,000 lb. of carbon dioxide per hour requires 1,300 sq. ft. of heating surface in the dissociator and a lye flow of approximately 400 gal. per minute. Potassium carbonate is used extensively, since it has a much greater solubility than sodium carbonate. Such lye at approximately 28 deg. Bé., or a specific gravity of 1.22, contains 19.6 lb. of potassium carbonate per cubic foot. Although the solubility of potassium carbonate is greater than that of the sodium carbonate, on dissociation 100 lb. of sodium bicarbonate yields 26.19 lb. of CO_2, while potassium carbonate yields only 22 lb.

The standard process is simple to operate, but the capital investment is large per ton of CO_2. Furthermore, the absorption efficiency at best is only about 50 per cent, and during the dissociation for every pound of CO_2 liberated, from 10 to 12 lb. of water must be evaporated at a boiler pressure of 20 to 25 lb. Finally, flue gases containing less than 14 per cent CO_2 cannot be handled economically.

Owing to these difficulties with the standard absorption process, as enumerated above, the author attempted to develop a process which would overcome the defects and at the same time utilize alkali carbonate as the absorption medium. Such an absorbent, besides being inexpensive, imparts no taste or odor to the CO_2, is not volatile or flammable, and hence is suitable for use in plants where these characteristics for an absorption material are very desirable.

The essential and characteristic feature of the author's process for the recovery of CO_2 from flue gas (for which patents are granted and several pending) consists in carbonating a saturated solution of alkali bicarbon-

ate and alkali carbonate to produce a solution containing solid alkali bicarbonate in suspension. The suspended solid bicarbonate is then dissociated to alkali carbonate and CO_2 by means of heat, leaving a solution still saturated with bicarbonate. This permits the recovery of CO_2 more efficiently, with lower heat expenditure and smaller heating surface than by the standard absorption process.

It is well known that the heat required to dissociate alkali bicarbonate in solid form, as practiced in the ammonia-soda process, is less than that required to dissociate in solution. Furthermore, when the dissociation is carried out with solid bicarbonate, the bulk is much smaller, and the size of apparatus required for a given production of CO_2 is greatly reduced.

However, the handling of the solid sodium bicarbonate for the principal production of CO_2 is mechanically difficult and expensive. If one processes solid bicarbonate as a *slurry*, instead, the mechanical difficulties encountered in handling solid bicarbonate alone are eliminated and the fluid character permits pumping and easy dissociation of the suspended material. The rate of liberation of the CO_2 from suspended bicarbonate in saturated solution is more than twice that from a saturated solution containing no sodium bicarbonate in suspension, and almost 500 times greater than the rate from the lye used in the standard absorption process. Whereas the rate of liberation from a saturated solution quickly falls off to a low figure, the rate of liberation from a suspension is maintained substantially constant as long as any solid sodium bicarbonate is present.

With the liberation of CO_2, water is also evaporated in the standard process at 20-25 lb. pressure (259-268 deg. F.), while in the improved process the maximum pressure is 5 lb. (220 deg. F.). Curve (1) of Fig. 3 shows the amount of water evaporated at 212 deg. F. per unit of CO_2 liberated from a saturated sodium bicarbonate solution, while Curve (2) shows also evaporation from a slurry containing bicarbonate in suspension. The great reduction in water evaporated from suspended sodium bicarbonate represents a large saving in fuel requirements during the dissociation operation. Note that the graph compares a saturated solution with suspended sodium bicarbonate. Actually, in present practice, saturated solutions have not been used. Hence, the fuel requirements in the standard process are actually much greater than would be indicated.

In order to obtain the highest efficiency in the new process, it is preferred to maintain the liquid in the dissociator always saturated with alkali bicarbonate. In fact to leave a small amount of suspended material present in the liquid coming from the dissociator might be preferable. The apparatus consists of the following parts as shown in Fig. 4: an absorber, settler, preheater and dissociator. In conjunction with this equipment are coolers and mixers.

Reich Process Equipment

Flue gas, free of SO_2 and H_2S, and containing 12 to 14 per cent of CO_2, passes into the absorber which can be either vertical or horizontal. Fig. 4 shows a vertical absorber provided with agitators, so that the flue gas entering at the bottom of the absorber is forced through against the hydrostatic pressure of the solution, which is less than 5 lb. gage pressure. During its passage through the absorber the gas stream is continuously broken up by specially designed agitators. Interesting facts were brought out by using this type of absorber: that while the rate of absorption did not decrease noticeably, nevertheless the alkaline content dropped from 25 lb. of sodium carbonate per 100 lb. of water to a saturated solution of 9 lb. of sodium carbonate and 10 lb. of sodium bicarbonate per 100 lb. of water at 110-120 deg. F.

During the passage of the flue gas through the absorber, the CO_2 content is decreased 85 per cent, so that a flue gas entering with 14 per cent CO_2 contains in the exit gas only 2 per cent CO_2. The rate of absorption of CO_2 and the formation of sodium bicarbonate is extremely rapid. Owing to the high concentration of the alkaline solution entering the absorber, a voluminous precipitate of sodium bicarbonate is quickly formed which does not appear to interfere with the rate of absorption.

The carbonated liquor containing a large amount of solid bicarbonate in suspension is fed to a settler for the separation of the suspension. The settled bicarbonate is removed as a slurry and part of the clear solution, free of suspended solids, passes immediately to the absorber while the remainder of the liquid, mixed with the highly concentrated hot lye discharged from the dissociator, serves for dilution purposes.

The slurry consists of approximately 10 lb. of sodium carbonate and 50 lb. of sodium bicarbonate per 100 lb. of water. In practice we can carry up to 70 lb. of bicarbonate or more per 100 lb. of water. This slurry passes first through a preheater where it is heated by the hot CO_2 gas issuing from the dissociator. From the preheater the slurry descends into the dissociator where a temperature of approximately 220 deg. F. is maintained. For a predetermined time, the slurry stays in the dissociator and the suspended bicarbonate (and probably a very small percentage of dissolved bicarbonate) becomes dissociated into CO_2, which passes into a gas holder, and sodium carbonate which goes into solution. The length and design of the dissociator is such that by slowly agitating the slurry the time required for the passage through the dissociator is sufficient to liberate the CO_2 from the suspended and part of the dissolved sodium bicarbonate. The "weak lye" leaving the dissociator is a clear solution containing at least 85 per cent of the alkali as carbonate. This is mixed with part of the clear solution from the settler and after cooling to 100-120 deg. F., is returned to the absorber to be recarbonated, and the cycle repeated. About 1 gal. of slurry fed to the dissociator yields 1 lb. of CO_2, compared to 10-12 gal. of liquid as required in the standard process. The CO_2 given off by the dissociation of the solid sodium bicarbonate is partially cooled during its passage through the preheater and further cooled in the water cooler where the water vapors entrained with the CO_2 gas are condensed and returned to the "strong lye" so as to maintain a uniform density. During the dissociation approximately 1 lb. of water is carried away per pound of CO_2 liberated per hour. The gas collected has a purity of 99.8 per cent CO_2.

Comparison of Standard Absorption Process and Reich Process

(Based on production of 2,000 lb. CO_2 per hour from flue gas containing 14 per cent CO_2)

	Standard Absorption Process	Reich Process
Per cent CO_2 in flue gas..	14	14
Per cent CO_2 in exit gas..	8.4	2.0
Per cent CO_2 absorbed...	40.0	85.7
Flue gas flow, cu. ft. per min..................	5,145	2,375
Number of absorbers.....	4	2
Size of absorbers, ft.......	10x100	6x20x10
Absorption space, gal....	235,000	18,000
Absorption space, cu. ft..	31,400	2,400
Na_2O per cu. ft., lb......	4.1–4.7	14.6–17.5
"Weak lye" per min. to absorber, gal..........	1,600	150
"Strong lye" or slurry per min. to dissociator, gal.	400	33
Dissociator heating surface, sq. ft............	1,300*	300
Absorber temp., deg. F.	120	120
Dissociator temp., deg. F.	260*	220
Water evaporated, lb. per hr..................	20,000	2,000

* Applies also to lime-kiln and coke gas

In the accompanying tabulation a comparison is made between the standard process and the author's process, showing the various amounts of gas, liquids and heating surfaces required, as well as the water evaporated for the production of 2,000 lb. of CO_2 per hour, when flue gas containing 14 per cent of CO_2 is to be processed. According to this table, the standard process handles 1,600 gal. of "weak lye" per minute going to the absorber, compared to 150 gal. for the author's process. The "strong lye" fed to lye boiler amounts to 400 gal. per minute (requiring 1,300 sq. ft. of heating surface) compared with 33 gal. of slurry per minute in the author's process (with a heating surface of 300 sq. ft.). Finally, the standard process evaporates 20,000 lb. of water per hour (10 pounds of water per pound of CO_2) compared to 2,000 lb. when a slurry is to be dissociated.

While this absorption process has been described primarily for the manufacture of CO_2, it can be applied also in the alkali industry, using a highly concentrated slurry, producing carbonate and simultaneously liberating a 99.8 per cent CO_2. The slurry can be concentrated almost to dryness and then calcined in much smaller furnaces than used at present; or by use of spray dryers it can be made into a light soda ash, using waste gas as the heating medium. This process is also suitable in the chemical industry where the presence of the CO_2 interferes with the smooth operation of the reaction and its removal is desirable, and where the presence of water is not objectionable.

The future of the solid CO_2 industry will shift more and more from the so-called "stationary" plants to "mobile" plants. It is desirable to have plants which can be transported from place to place. The "stationary" system requires large absorbers, much ground space, great height, a solid foundation, and is quite expensive. Therefore, such plants are mostly centrally located and can not contribute to the wide-spread use of solid CO_2 which this refrigerant justly deserves. In the author's opinion what is needed is "mobilice" plants, consisting of small units and lighter, more compact equipment.

The author's prediction may appear somewhat visionary. However, he cannot help but think that the time will come when solid CO_2 plants will be sold as a standard article, like air conditioning equipment. We need such plants using inexpensive chemicals which are non-poisonous, non-flammable and non-volatile. Mobile plants for CO_2 could be transported from place to place, so that railroads or steamers could produce their own liquid or solid CO_2 when and where desired.

For instance, it is not profitable to take solid CO_2 to the tropics, collect such cargo as fruit or meat from country to country and bring the freight back refrigerated with solid CO_2. On the other hand, with mobile ice plants steamers could produce their own liquid CO_2 from their own flue gases in small, compact units, expand the liquid in the hold, producing part solid CO_2 snow, and part gaseous CO_2, thus creating a rapid cooling, with an active circulation in the storage room due to the expanding liquid CO_2. Carbon dioxide snow represents 15-25 per cent of the liquid expanded and acts like the solid CO_2 now being marketed, with the difference of subliming more quickly, which in this case would be desirable. The gaseous CO_2 could be recycled and by using an absorption system a slight dilution would not matter. The recycling would have the advantage that odors and heat would be removed very rapidly and would inhibit mold growth, thus utilizing a cold, indifferent, pure gas as a direct refrigerant. Deodorization and sterilization of the recycled gas could be accomplished by another of the author's processes (U. S. pats. 1,519,932, 2,122,586). The loss of CO_2 through air infiltration could be made up from the flue gas produced on the boat.

In conclusion the author desires to express his appreciation to Mr. W. H. Hoodless, president, and Arthur L. Simmers and Harry Gold of the Pennsylvania Sugar Co. for their wholehearted cooperation in the development described here.

Viscosity of Strong Phosphoric Acids

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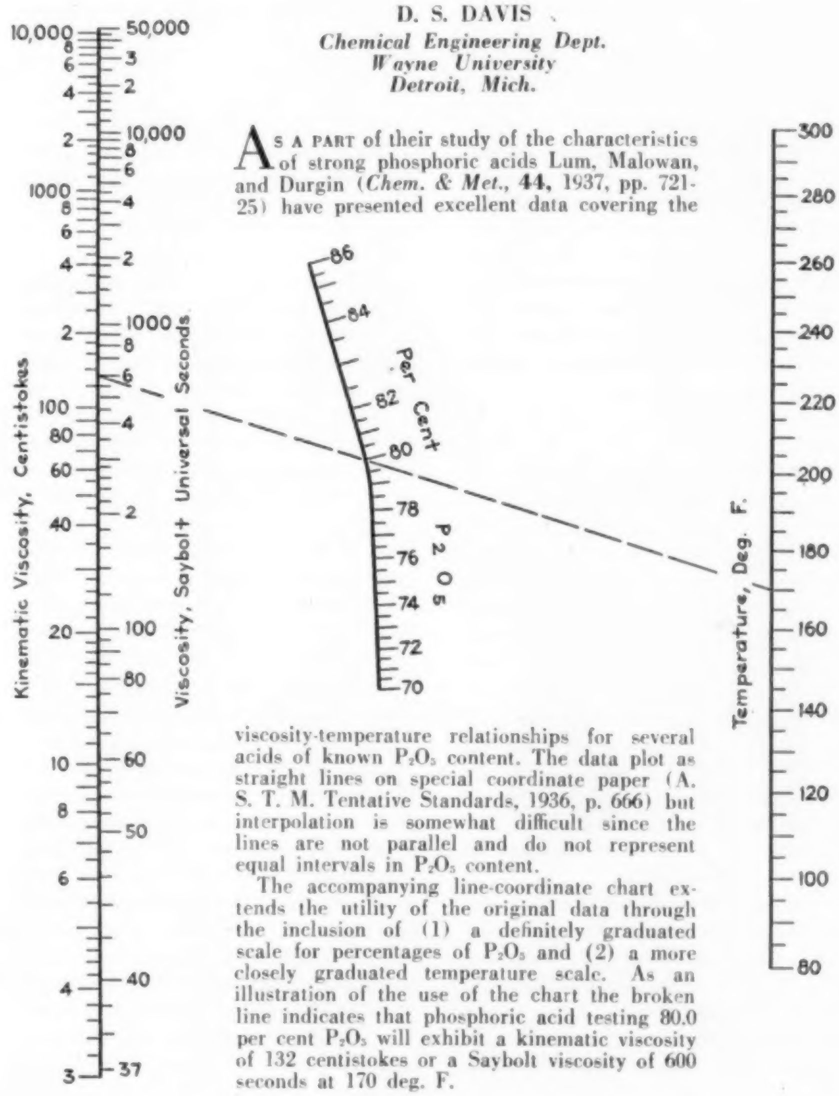
As a part of their study of the characteristics of strong phosphoric acids Lum, Malowan, and Durgin (*Chem. & Met.*, **44**, 1937, pp. 721-25) have presented excellent data covering the viscosity-temperature relationships for several acids of known P_2O_5 content. The data plot as straight lines on special coordinate paper (A. S. T. M. Tentative Standards, 1936, p. 666) but interpolation is somewhat difficult since the lines are not parallel and do not represent equal intervals in P_2O_5 content.

The accompanying line-coordinate chart extends the utility of the original data through the inclusion of (1) a definitely graduated scale for percentages of P_2O_5 and (2) a more closely graduated temperature scale. As an illustration of the use of the chart the broken line indicates that phosphoric acid testing 80.0 per cent P_2O_5 will exhibit a kinematic viscosity of 132 centistokes or a Saybolt viscosity of 600 seconds at 170 deg. F.



Executive vs. Technologist

To promote a proper understanding between management and research, the American Section of the Society of Chemical Industry brought together a prominent chemical executive and a leading petroleum technologist. Their conflicting yet confirming viewpoints make for more constructive cooperation.

Editor's Note: Chemical engineers who listened to the stimulating debate at the Biltmore Hotel in New York on Feb. 16, held under the chairmanship of Dr. Wallace P. Cohoe, could not help but feel that more frequent discussions of this sort would help to clarify misunderstandings and stimulate better relations between executives and their technical personnel. Chem. & Met. *presents herewith a brief digest of some of the most interesting sections of these two papers.*

What Management Thinks

By WILLIAM BROWN BELL

American Cyanamid Company's able president was born at Stroudsburg, Pa., in 1879. He received his A.B. degree from Haverford College, his M.A. in Political Science from Columbia University and the LL.B. from the same institution in 1903. A director and president of American Cyanamid Co. since 1922, he has also served two terms as president of the Manufacturing Chemists' Association and of Chemical Alliance, Inc. His yacht, Elena, won the King's Cup in the Spanish ocean race in 1928. He is a member of Phi Beta Kappa and of the University Club, Metropolitan Club, Century Club, Union League, New York Yacht Club, Royal London Yacht Club, Royal Thames Yacht Club and Royal Sporting Club of Spain.

ONCE upon a time we would not have gathered to discuss this subject of "The Executive and The Technologist—A Proper Understanding Between Them." A century ago, when the chemical industry in America was young, there was little division between these groups. It couldn't have been otherwise. There were too few amongst whom to divide authority in those institutions that subsequently became famous under the names of Harrison, Cochrane, Grasselli, Kalbfleisch and others. When the du Pont company was founded 138 years ago, at least so I have been told, the chief executive and the chief technologist were one and the same, Mr. Eleuthere Irenee du Pont. Just how he divided authority with himself is not recorded but obviously he must have reached a "proper understanding."

Today, even though the executive may be a technologist, the need for competent technicians to keep his desk clear of scientific problems is plain as is also the need for other executives to carry out the many administrative programs. Spread more or less equally amongst this executive staff is the responsibility of seeing that our specialists and all others perform the duties for which their background and talents best fit them and that their efforts are properly coordinated. It is this staff which answers such questions as: Do we lack proper lines of organization? Or do we err in the other direction? Do we fail to recognize that special ability or the lack of it at strategic points in the organization blueprint requires flexibility with constant modification of flow lines? What about the adequacy of sales coverage? Do our sales divisions sell the old established, easily marketed lines alone or are they exercising proper skill and perseverance in building up new products? Do our plants attempt maintenance and engineering better serviced by specialists in our organization? Is our purchasing economical and far-sighted? Does any unit need cutting down, expansion or reorganization?

The small percentage of research successes likely imposes a special duty on the general staff. Each division head is probably reluctant to run the risk of failures in the few research projects which his department should undertake because these failures will be charged against his operations. The general executives, familiar with some hundreds of research projects underway for all departments and reasonably confident that some of them will succeed and more than carry the rest, should insist on as comprehensive a program as the company's situation and a careful selection of projects may warrant.

THE maintenance of quality, safety, efficiency and other considerations is not only essential to success as ordinarily defined but, in our business, to the preservation of life itself, both in our people and those whom we serve. Having selected, as best we can, the executives and their immediate assistants, we now impose on this group—the chief executive among them—the legal responsibility for the whole company. They must command the moral confidence to integrate all units so they may function efficiently and return the maximum of productivity. Perhaps you may think that the existence of a large group of executives, supported by many experts, each an authority in his field, tends

to complicate problems and make decisions difficult. Quite the contrary. When those to whom a particular investigation belongs have discussed the situation from all angles, one need only listen—with as much of an appearance of wisdom as he can assume—to their conclusions. The answer is usually obvious. One confirms the only decision possible.

You will recognize that all this is not a communistic set-up. Even Russia has abandoned the attempt to administer corporate affairs by the workers themselves. There can no more be division of responsibility in chemical manufacture than aboard ship. Divided responsibility in the chemical industry would mean inefficiency, waste, higher costs, stoppage of progress and paralysis in general. At its worst, it would result in disorder, explosions, the poisoning of both workers and consumers. It is not to be considered.

In this outline that I have given to some of the chief sectors of a chemical company's organization, one of the prime problems is, of course, the selection of executives and of their associates and chief assistants.

FUNDAMENTALLY, the difference between the position of the technologist and that of the executive is that the former deals with phenomena capable of direct and relatively precise measure. The executive, using this information as a background, must project more into the unknown, include other factors more or less tangible, take a cross section far more absolute and, upon this, formulate a decision. No one wishes more than the executive that all factors could be reduced to pounds or feet or dollars, that the problem could be put on the calculating machine and the answer turned out.

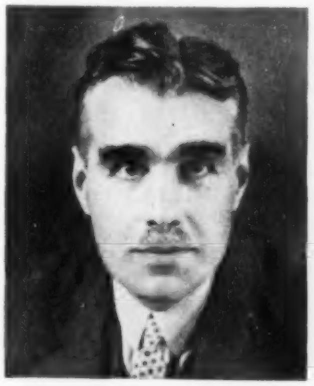
HOW do we recruit our executives? The executive activities in our organization are aided and, in some divisions, entirely supported, even dominated by technologists. There is, of course, no sharp line of demarcation between the two kinds of men,—the technical man and the man who comes in by some other route. Both are human beings—Washington to the contrary notwithstanding. The technologist enjoys a certain advantage in a field as scientific as the chemical industry. He may, as an executive, successfully utilize his special knowledge in quick determination of the wisdom of embarking on certain chemical projects. On the other hand, he must be able to recognize that, with several hundred chemists and engineers in his organization, he has at his disposal the knowledge of specialists in many fields which no one human mind can hope to cover completely. Once he ventures outside his chosen field or away from subjects on which he is strictly up to date, his decisions, like those of executives generally, should, even on technical questions, be made only after consideration of the facts gathered by and the recommendations of those to whom he should look for advice. If these facts are borne in mind, the transfer of a technologist to the executive group—some technologists refuse transfer because they prefer to continue to deal with precise measures alone—may easily prove successful.

It is vital that the technologist in an executive position possess that peculiar ability to appraise factors, some of which are not precise but which are necessary to the equation. Possession of this faculty can, so far as I know, be determined only by trial and error. Meanwhile, it is obvious that a possessor of these necessary qualifications may be found in all ranks—that is, indeed, if he is to be found in any.

Let me say that there is no group of men in our business more interesting and more delightful to work with than the chemists who conduct our research and our technologists who guide us at every turn. With them one enters the realm of precision—in alluring contrast to that of the executive. The technologists are men of ideas and those ideas are of profound interest, not only from the company's point of view, but because they are the ideas that in the years to come will lower costs, really distribute wealth and actually achieve the more abundant life for all. Frequently these are the ideas that will relieve suffering and prolong life. They are the ideas that will advance humanity. We executives can back you and we will. Upon your vision, ability and sound judgment the success of vast chemical enterprises must ultimately depend, and more than that, the progress of the whole world.

From the Research Viewpoint

By EVAN CLIFFORD WILLIAMS



Shell Development Company's vice president and director of research was born in England in 1892. He received his M.Sc. degree from Manchester and D.Sc. degree from University College in London in 1916. After serving as research chemist and manager of the intermediates department for British Dyestuffs Corp. and later with the National Benzole Association, he was appointed Ramsay Memorial professor of chemical engineering in London in 1923. Five years later he resigned to become director of research for the Shell Development Co. He is a member of the American Institute of Chemical Engineers, British Institution of Chemical Engineers, American Chemical Society, Electrochemical Society, and several European Societies.

A DISTINGUISHED writer has recently referred to science as "at once the noblest flower of the human mind and the most promising source of material benefactions," and if I understand my task it is to consider how unity of outlook can best be achieved between the scientist and those most interested in the material benefactions. While I would not admit that the executive and the technologist in our more progressive industries are indeed so far apart, it is true that there must be complete harmony between them if the greatest results are to be secured.

To simplify my own theme and bring it within reasonable bounds for a short discussion, I will assume that the word technologist does not include the army of technological experts who keep an established industry running—for there is no question as to their function nor any failure on the

part of executives to appreciate and promote their work—but, those, fewer in number, whose job it is to steer industry into new channels either by the improvement of existing manufacturing processes or by the creation of new products and industries. It is those research workers—chemists, physicists and engineers who have become both creative and disruptive forces of industry who are regarded by executives, according to their individual tastes as either their greatest hope or their greatest embarrassment.

THE research director is a kind of between executive and research minds is a study not only in industrial planning but in the psychology of individuals. It is apparent, as your chairman, Dr. Cohoe, wrote to me, that executives, as representatives of capital, and technologists do not speak the same language and consequently misunderstand each other. "The technologist thinks the executive considers money only; while the executive tells the technologist that he is too theoretical." I would ask you to note a distinction in words — the technologist "thinks" but the executive "tells."

I do not imagine that his choice of words was anything but a coincidence yet it happens to illustrate what is perhaps a real factor in our problem. Of course, none of us doubts that the executive thinks as acutely as the scientist, yet we may recognize a certain absolute value in what he says; a value arising unavoidably from the prestige and authority which surround his office.

A good executive has the gift, after hearing many sides of a question, of sifting intangible factors and arriving, sometimes apparently by intuition, at a decision. Sometimes to his colleagues his decision seems hastily or casually arrived at, sometimes they think it crazy. But if in course of time his decisions prove correct often enough, if his batting average is high, he quickly becomes accepted as a great executive—and he is.

But remember, the more he is accepted as a great executive the more, as we have seen, do his beliefs tend to influence facts, or even become facts, merely because they are his beliefs. So his chances of proving right increase in geometric progression as his reputation increases. His prestige is self perpetuating; it grows so to speak on its own fat.

Now that is a dangerous state for the executive; as it is for a dictator. Unless he is essentially modest, progressive, and receptive to new ideas, he becomes the acme of established authority, sometimes of conservative unimaginative authority.

It is easy to see how this attitude of mind may clash with that of the research worker. It is the latter's task to create new things. He deals with things yet unproved; he is always weighing risk of failure against promise of success. He, too, like the executive, has his intuitions; his too are sometimes thought to be crazy; and his too, sometimes prove correct. The more often they do, the greater becomes his prestige.

But, and here the difference begins, the beliefs or intuitions of the research worker never at any time have the slightest influence on the facts. Neither do they, merely by being expressed by him, acquire the slightest actuality, whatever his prestige or authority. His own most junior laboratory assistant may, by well directed experiment, prove him wrong.

Long experience of such fallibility tends to breed a skepticism in the scientist's mind for vested prestige or accepted beliefs as such—including his own. It is a pity when executives, meeting such skepticism or disbelief in established authority, which is one of the most essential characteristics of the productive scientist, see in it only a lese majesty or a reluctance to pull along like a decent fellow—"just as the rest of us do."

UNTIL the time when more executives in modern industry are recruited through the technical or scientific departments there must be an interim during which the research leader and the more traditional type of executive with financial or sales or legal background will have to make conscious efforts toward mental adjustments. But that should not be difficult to intelligent men. The platitudes that executives think only of money and that research men are theoretical and impractical are signs of adolescent thinking or obstructive conservatism. There are, of course, individual examples to support both statements but modern industry does not depend on them.

The executive of today devotes a large part of his thought to the understanding of the basic processes of his industry and the research leaders who come into contact with the executives are persons of broad background with sufficient knowledge and sense to understand and appreciate the problems of executive control.

There are, however, some differences between the backgrounds of the executive and research types and the conditions surrounding their work. The problems of a top executive are concerned largely with financial, organizational, commercial and political affairs, and increasingly with labor relations. These are primarily problems in human relationships. His technique must include a native gift for leadership, power of persuasion, of estimating intangible probabilities, willingness to compromise difficult issues, exercise of personal will or determination where compromise is impossible. At all costs the machine must be kept working smoothly and to that end all discordant or strongly individualistic policies tend to be suppressed.

The research leader, on the other hand while needing the same characteristics as the executive in his dealings with men (and no one has more complex human relationships to handle than the leader of any large research group) is vitally concerned also with coldly material things, chemical reactions, properties of matter and forces of nature. No amount of personality, persuasion or will can influence such forces. Neither is it possible to compromise them for the sake of peace, good will and good fellowship.

If the scientist compromises on something for which he should have data, his mistakes like those of the doctor remain starkly to condemn him. The ghosts of the executive do not rise so quickly and if he is smarter than those around him they may not rise at all. It may never be known that there are any ghosts.

Just as the executive, if he is to get full value from research in his organization, must recognize these aspects of scientific work, so the research leader must gear himself with those on whom he depends for the constructive application of his work in industry. The research leader must be a salesman, selling ideas, things which cannot be seen or handled; things which, to his colleagues at least, are somewhat speculative and intangible. This requires good salesmanship even when there is no sales resistance.

THE research director is a kind of crystal gazer for industry, without the hocus-pocus. The picture in the crystal for a year ahead is rather clear; further into the future it may be blurred, yet formed in its main outline; even up to five or ten years ahead him, forms can be seen through the fog. These are not unsubstantial

dreams, they are definite indications of future movements in industry.

I suppose the ideal non-technical executive from the research leader's point of view is one who, whatever his original background, will analyze keenly and objectively the many factors of a new situation in an attempt to appraise their bearing on the future. He will not attempt to fit new conceptions into some ancient pigeonhole of the mind bequeathed to him by some revered predecessor and since worn smooth by continued effort to fit every new proposal into it.

There are many principles which applied to an established concern are the essence of sound business but which applied to new ventures can be extremely stultifying. It is impossible to forecast the future with the precision that one can record the past, and the purely accounting mind is inclined to attempt that or to shrink away where he finds it impossible.

I have had so much help from the highest executives with whom I have associated and seen so much wisdom in their approach to difficult problems lying outside the current operations of their industry that I am tempted to emphasize the particular influence of the top executives, without which very often no progressive research could be done.

Strangely enough that influence is intangible rather than specific, human rather than purely factual and logical. That may seem contradictory to those who regard technical advances as arising from the slow, logical accumulation of data. In truth, the research worker needs more hidden springs of courage and faith in future success to support him than almost any other worker.

SUCCESSFUL research will only be done when someone starts by intensively believing that something can be done. For each step successfully accomplished there are usually many steps that fail and so it goes on to the end. It is often difficult to tell even after a venture has proved successful at just what point success was assured. It is much more difficult to tell while you are still in the middle of things.

This is why it is so extraordinarily difficult for a research worker to say with definiteness, while he is yet on the way, that he will ever arrive, or when, or what he will have when he gets there. And that is also why it is so easy for people, other departmental groups for example, Treasurers, Sales Managers, Production Heads, Budgetary Officers, Administrators, to expose with such clarity the risks, expense or uselessness of going on.

It is here that the influence of the top executive is so powerful and necessary. He alone, under such conditions, can release the energies of his whole organization to complete industrially and socially the cycle of research. No research is completed, industrially, until it has been applied and has become an accepted industrial activity; nor socially until it is affecting the prosperity and well being of peoples. It is a great incentive to research workers to know that their work is contributing to the industrial and social advance of their times, and in this they are with the enlightened industrial leaders.

DEPARTMENTAL executives take their cue from him; it is for him to give the cue of far-sighted outlook and willingness to advance the uncertain potentialities by cooperative work. It is for him to understand not only what science may do for him and his industry, but also that which he must do to enable research to play its part successfully.

If there is this executive initiative toward major new fields of research, so much the better. That would be ideal—commercial initiative stimulating scientific initiative with each reacting to the other but not waiting for the other to make the first move.

Many of today's most progressive modern industries still show the influence, if not the names, of the pioneer research workers or technologists who gave them birth. They retain a tradition of faith in technological advances based on research. They see to it that a large proportion of their recruits for leading executive positions are scientifically educated. They seem to find no difficulty moreover in conducting the financial, commercial, selling and distributing activities of their business; but they do not forget where the real foundations of their businesses lie. It is the industries which do not have such a past tradition which need to think constructively about their relation to research.

What was good enough for a top executive only a few years ago is not likely to be good enough for the conditions of the future. Research has ceased to be merely incidental operating control and has become an essential pillar of industry. We may regard the three essential pillars as, capital, science and labor. The understanding and harmonious welding of these three into a smoothly running organization is the supreme task of the executive. Law, finance, operations, accounting, important as they may be, compared with these three are merely routine mechanisms for guarding our property, keeping it working and recording the results of its operation.

We may learn something from the investment counselor, who with responsibility for the investment for funds, has the task of appraising the health of industrial organizations. What does he look at? The annual balance sheets, of course, and dissects them, item by item, trading returns, costs of production, sales profits, taxes, assets, tangible and intangible and so on. But these are only records of the past. They do not show the asset of intellectual property, which is the guarantee for future health, and it is to this item that the shrewd analyst directs a special probe.

He wants to know what amounts are spent on research, what is the quality of the men in the research laboratories, what is the attitude of the management towards them, and what are the past achievements. He recognizes that it is in the intellectual caliber of the research men that the potential of modern industry lies; but he recognizes also that potential can never be reached without equal vision and courage in the executive departments.

Mr. Bell has told you what the executive seeks from research; let me conclude by summarizing what research seeks in the executive.

A mutual unity of aims cultivated through personal contact.

Power of critical analysis supported, not dominated, by position or past history.

Courage in commercial affairs equal to the courage expected in technical affairs.

Enthusiasm to inspire greater effort when the objective is good but the going hard.

A patent anxiety to see opportunities in difficulties rather than difficulties in opportunities.

That attribute of all great executives of making any man feel bigger and capable of more through having talked with him.

I said I would summarize what the research man seeks in the executive; I am not sure that I have not equally summarized what the executive should seek in the research man. At any rate, there you have a combination fit to tackle the world—to assure prosperity in peace and security in war.

Typical Problems in Drying

Concluding the discussion, started in Chem. & Met. *last January, of representative types of dryer problems; the solutions which have been worked out are illustrative of recent advances in the theory of drying and the application of drying equations.*

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Design problems presented in this and the preceding article (*Chem. & Met.*, Jan. 1940, p. 15), deal with calculations of drying time, optimum air velocity, optimum recirculation of air, weight and heat balances, and steam power requirements. The calculation and selection of heat exchangers and optimum thickness of insulation are also involved, but these are problems in heat transmission and hence were not included in these discussions. Other important problems are in the selection of motors, fans, temperature and humidity controllers and recorders. These latter require access to manufacturers' catalogs.

Numerous highly important problems in mechanical design remain, such as methods of supporting stock, conveyor systems for moving stock, framework of dryer, walls, roof and floor. The design of doors, provisions for accessibility to inspection and repair, supports and ducts all require detailed sketching. Mechanical features require detailed shop drawings with time-consuming effort. Ordinarily these items are competently handled by design and mechanical engineering departments. While they are outside the scope of these discussions, they are an important part of the planning required for any new installation.

Problem III—Drying During the Falling-Rate Period.

Optimum Rate of Air Flow Through the Stock

This problem is of particular interest since it represents an actual commercial design when calculations are made for variations in moisture contents of the stock and of the air throughout the entire length of dryer.

A progressive dryer is desired for drying 10,000 skins of chrome leather per 24 hours. The inside vertical cross-section of the dryer is 10.7 ft. wide by 7 ft. high. The skins are hung crosswise, $2\frac{1}{2}$ in. apart, three abreast, averaging 8.6 skins per foot of length. Propeller fans are placed above the stock at 10-ft. intervals to circulate the air downward through the vertical sheets, and to bypass it through side channels on each side of the dryer to the adjoining ten foot section. The cross section of the air stream is thus 107 sq.ft. as it passes down through the leather. This spiral flow of air is necessary to insure a uniform circulation without channelling or temperature stratification. Air is taken from the outside at 80 deg. F., 70 per cent humidity, atmospheric pressure, and heated to 140 deg. F. before entering the dryer. The average weight of dry leather per skin is 1.162 lb. The initial moisture content of the stock is 1.562 lb. per pound of dry leather. $T_o = 1.562$. The average thickness of the skin is 1.03 mm. It is desired to dry this leather to a final moisture content of 9 per cent, $T_i = 0.099$.

Table I—Equilibrium moisture contents of skins, lb. per lb. of dry stock

Relative humidity, per cent	Equilibrium moisture content at various temperatures: 80°F	100°F	120°F	140°F
10	0.071	0.060	0.048	0.040
20	0.103	0.090	0.080	0.070
30	0.128	0.115	0.105	0.095
40	0.152	0.140	0.129	0.118
50	0.173	0.162	0.153	0.142
60	0.198	0.190	0.181	0.170
70	0.232	0.222	0.212	0.200
80	0.282	0.270	0.255	0.245
90	0.352	0.338	0.323	0.305

In drying this material, evaporation is the controlling factor and drying takes place from both sides of the sheet. The drying equation is

$$\frac{dF}{d\theta'} = -\frac{0.00239}{L} G^{0.6} F \Delta H \qquad (8)$$

The cost of dryer construction including fans and heating coils in the side channels is $50.00 per foot of dryer length (or $500 per 10-ft. section). The annual cost of interest, depreciation and taxes is 25 per cent. The cost of steam is 50c. per million B.t.u. The cost of power is 2c. per horse-power hour. The horsepower required for blowing air through the dryer per ten foot section is given by the equation 0.004 $G^{3.0}$. The heat loss through the insulated walls of the dryer is 605 B.t.u. per hour per foot of dryer length. Drying is to be carried on 7,200 hours per year (300 days).

Solution—This problem is solved by calculating the time and length of dryer required at various values of air velocity and the corresponding annual costs of equipment due to interest, depreciation and taxes, of heat losses by radiation, of power, of steam for preheating air and evaporating water.

Typical calculations are made for an air flow of 4 lb. per min.-sq.ft.; $G = 4$.

$$L = 1.03 \text{ mm.} = 0.00337 \text{ ft.}$$

Hence, Equation (8) becomes

$$\frac{dF}{d\theta'} = -\frac{0.00239}{0.00337}(4)^{0.6} F \Delta H = -1.625 \Delta H \qquad (9)$$

Based on a paper titled "Drier Calculations and Designs" presented before the Summer School for Chemical Engineering Teachers at Pennsylvania State College, June 27, 1939.

The total air flow through stock is $GA = (4)\ (107) = 428$ lb. per minute.

The number of sheets dried per minute

$$= \frac{10{,}000}{24 \times 60} = 6.95.$$

The weight of dry stock dried per minute $= 6.95 \times 1.162 = 8.15$.

$$r = \frac{\text{rate of air}}{\text{rate of dry stock}} = \frac{428}{8.15} = 52.5$$

The humidity of the air leaving the dryer, H_l, may be obtained from the moisture balance.

$$T_e - T_l = r\,(H_l - H_e)$$
$$1.562 - 0.099 = 52.5\,(H_l - 0.0152)$$
$$H_l = 0.0431$$

The corresponding values of wet bulb temperature, percentage humidity, and wet bulb humidity may be obtained from a humidity chart. Values of equilibrium moisture content, which varies with both temperature and relative humidity, are obtained from Table I. Conditions at the terminals of the dryer are given in table II. Corresponding values at any intermediate state of drying can be similarly obtained starting with the weight balance,

$$T_e - T = r\,(H_l - H).$$

The time of drying θ', can be obtained by graphical integration of the following equation where ΔH is a function of F.

$$\theta' = \frac{1}{1.625}\int_{F_l}^{F_e} \frac{dF}{F\,\Delta H} \qquad \text{(9a)}$$

In this instance, however, ΔH does not vary greatly throughout the length of the dryer so that an arithmetic value may be taken, $\Delta H_{avg.} = \frac{1}{2}(0.0126 + 0.0083) = 0.0105$. With this substitution, $\theta' = 192$ min.

The total weight of stock in the dryer in any instant must equal the time of drying times the weight dried per minute $= (192)\ (8.15) = 1{,}560$ lb.

The weight of dry stock per foot of dryer $= 1.162 \times 8.6 = 10$ lb. Hence the required length of dryer $=$

$$1{,}560 \div 10 = 156 \text{ ft.}$$

The annual cost of dryer per foot $=$ (.25) (\$50) $=$ \$12.50. The annual cost of heat losses by radiation from dryer $=$

$$\frac{(605)\ (7{,}200)\ (0.50)}{1{,}000{,}000} = \$2.18 \text{ per ft.}$$

The power required to circulate air through the leather and to the next fan 10 feet ahead is $0.0004\ G^3$ hp. The cost of power per year $=$ (.02) (7,200) $=$ \$144 per hp. year. When $G = 4$, the annual cost of power per foot of dryer is

$$\frac{(0.0256)\ (144)}{10} = \$0.369.$$

The cost of preheating the air per year may be obtained from the rate of flow, temperature rise in preheating, humid heat of air, and cost of steam; this becomes $(107)\ (60) G\ (7{,}200)\ (140\text{–}80)\ (2.46)\ (.50) 10^{-6} = \$342\ G$ per year.

Since the air is maintained at 140 deg. F., steam must be supplied to coils in the side air ducts of the dryer. Water enters at 87 deg. F., and leaves as vapor at 140 deg. F.

Water evaporated per year $=$ (7,200) (8.15) (60) (1.562–0.099) $=$ 5,150,000 lb.

Cost of steam required

$$= \frac{(5{,}150{,}000)\ (1{,}009)\ (0.50)}{10^6}$$

$=$ \$2,600 per year, where 1,009 is heat supplied to 1 lb. of water evaporated.

Total annual cost when $G = 4$:

Dryer, fans, floor space (taxes, depreciation, interest)	\$2,020.00
Heat loss by radiation from dryer	354.00
Cost of power for blowing air	60.00
Cost of steam for preheating air	1,368.00
Cost of steam for evaporation	2,600.00
	\$6,402.00

To obtain the optimum velocity at which air should be blown through the stock, the above calculations must be repeated for different values of G. The results are given in Table III and Fig. 1. The minimum cost of \$6,402 comes at $G = 4$. The optimum velocity of air flow is therefore 4 lb. per min.-sq. ft.

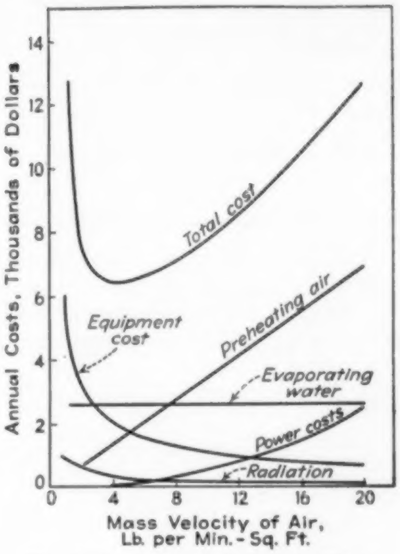


Fig. 1—Cost of drying with different air velocities

Optimum Fraction of Recirculated Air

The problem of calculating the optimum fraction of air to recirculate is of special interest and is not included in standard texts. To reduce the cost of preheating air it may be economical to recirculate a fraction of air supply back to the preheater and again through the dryer. This will require an increase in drying time and a corresponding increase in length of dryer.

Solution—Let $y =$ fraction of air recirculated. The flow chart is indicated in Fig. 2.

A weight balance of water is given as

$$T_e - T_l = r\,(1-y)\,(H_l - h_e) \qquad (10)$$

and $$T_e - T_l = r\,(H_l - H_e) \qquad (11)$$

where h_e = water content of fresh air

From (10) and (11), $(H_l - h_e)\,y = H_e - h_e \qquad (12)$

Let $y = 0.25$; $G = 4.0$

From Equation (10)

$$1.562 - 0.099 = 52.5\ (0.75)\ (H_l - 0.0152)$$
$$H_l = 0.0523$$
$$H_e = 0.25\,(0.0523) + 0.75\,(0.0152) = 0.0293$$

The conditions at the terminals of the dryer are given in Table IV.

Table II

At air entrance	At air exit
t_e = 140°F.	t_l = 140°F.
H_e = 0.0152	H_l = 0.0437
tw_e = 87°F.	tw_l = 106°F.
$\%h_e$ = 10%	$\%h_l$ = 29%
Hw_e = 0.0278	Hw_l = 0.052
ΔH_e = 0.0126	ΔH_l = 0.0083
T_l = 0.099	T_e = 1.562
E_l = 0.040	E_e = 0.092
F_l = 0.059	F_e = 1.470

Table III—Annual Cost for Various Air Velocities

G	Time min.	Length Ft.	Equipment	Radiation Losses	Power	Preheating Air	Evaporating Water	Total Cost
2	348	282	\$3530	\$615	\$44	\$684	\$2600	\$7473
4	200	162	2020	354	60	1368	2600	6402
8	122	98	1230	214	316	2736	2600	7096
12	96	78	980	170	820	4104	2600	8674
16	76	61	765	134	1470	5472	2600	10441
20	67	54	675	118	2560	6840	2600	12793

Table IV

Air Entrance	Air Exit
t_e = 140°F.	t_l = 140°F.
H_e = .0293	H_l = .0523
tw_e = 97.5°F.	tw_l = 111°F.
$\%h_e$ = 19%	$\%h_l$ = 34%
Hw_e = .040	Hw_l = .061
ΔH_e = .0107	ΔH_l = .0087
T_l = .099	T_e = 1.562
E_l = .068	E_e = .090
F_l = .031	F_e = 1.472

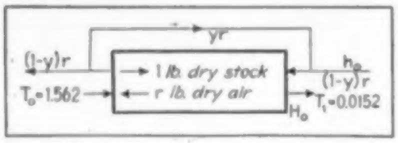


Fig. 2—Flow diagram of recirculating air

Again ΔH does not vary greatly in passing through the dryer, hence an average value may be used without resorting to graphical integration.

$$\Delta H_{avg.} = \frac{1}{2}(0.0107 + 0.0087) = 0.0097$$

from equation (9)

$$\int_{0.031}^{1.472} \frac{dF}{F} = 1.625\ (0.0097)\ \theta' \quad (13)$$

$\theta' = 237$ min. and $L = 193$ ft.

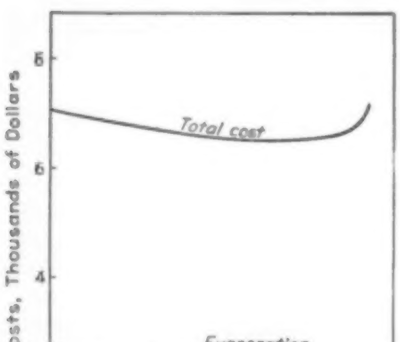
The costs of investment, heat losses by radiation, power and evaporation are calculated as in the previous example. The cost of preheating air is now equal to (1-y) times the cost of preheating all fresh air =

(1-y) 342 G dollars per year.

The optimum recirculation of air may now be obtained by adding all costs for a given value of G with various values of y. Table V and Fig. 3 give these costs when $G = 8$.

The optimum recirculation of air at $G = 8$ is 40 per cent. At $G = 4$, all fresh air should be used. Indeed, it is cheaper to use all fresh air at $G = 4$ (\$6,402) than to recirculate 40 per cent air at $G = 8$ (\$6,524). The most economical conditions of operations of operation are hence where $G = 4$ lbs. per sq.ft.-min. with all fresh air and with no recirculation of air.

Fig. 3—Cost of drying with different fractions of recirculated air



Adiabatic Drying

With adiabatic drying the wet bulb temperature of the air remains constant at 87 deg. F. Operation with an air flow of $G = 4$ is impossible because the air becomes saturated before drying is complete.

If a high air flow is assumed, for example, $G = 16.0$; then the drying equation becomes:

$$\frac{dW}{d\theta'} = -3.75\ W\ (H_w - H) \quad (14)$$

From the weight balance, humidity chart and equilibrium moisture table, the terminal conditions of the dryer may be obtained as before. (Table VI.)

If the equilibrium moisture content, E, were constant, Equation (14) could be integrated directly, since H_w is constant. But because of the variation of E the relation of H to W cannot be obtained by a weight balance. Graphical integration may be resorted to. Values of $1/F\Delta H$ are plotted against F and the area measured from $F_o = 1.42$ to $F_i = 0.059$. If, however, an arithmetic average value of $\Delta H_{avg.}$ is used, $\Delta H_{avg.} = \frac{1}{2}(0.0057 + 0.0126) = 0.00915$, then Equation (14) may be integrated directly and $\theta' = 93$ minutes. This value may be compared with 76 minutes for constant temperature drying at 140 deg. F., $G = 16$. Adiabatic drying will be found to be uneconomical.

Table VI

Air Entrance	Air Exit
t_o = 140°F.	t_i = 110°F.
tw_o = 87°F.	tw_i = 97°F.
$\%H_o$ = 10%	$\%H_i$ = 38%
Hw_o = .0278	Hw_i = .0278
H_o = .0152	H_i = .0221
ΔH_o = .0126	ΔH_i = .0057
T_i = .099	T_o = 1.562
E_i = .040	E_o = 0.142
F_i = .059	F_o = 1.42

Problem IV—Drying Through all Stages; Granular Material in a Tray Dryer.

The total time required to dry a substance can be easily obtained for any degree of drying if the drying rate curves over the entire range of drying and for the particular drying conditions are known. It is simply necessary to integrate under the reciprocal of the drying rate curve over the limits of initial and final moisture contents. Where the drying rate varies linearly with the moisture content, the average drying rate is equal to the logarithmic mean of the rates at the initial and final values of moisture content for a given period. In such curves drying rates per unit area of drying surface are plotted against the average moisture content on the dry basis. These curves are characteristic for each material and depend upon the dimensions, shape, and method of supporting the stock, and upon the temperature, humidity, velocity, and direction of flow of circulating air.

Typical drying rate curves[1] for sand are shown in Fig. 4 where the sand is placed in trays and air is blown over the top surface at average conditions of 7 m. per sec., 60 deg. C. and 10 per cent humidity and where the bottom of the tray is well insulated. Three stages of drying prevail and that the critical moisture contents depend upon the thickness of stock.

During the constant rate period the surface of the sand remains completely wet even though its moisture content on a dry weight basis diminishes. The first critical point occurs when the surface water film breaks and exposes a gradually reduced surface to evaporation with a corresponding reduction in the rate of evaporation. The structure of the water film in this period is termed the funicular state. Another break in the drying rate curve occurs when continuity of water film is no longer maintained in the water wedged between the grains, the so-called pendular state. and the surface of water evaporating begins to retreat progressively below the surface of the sand.

When the sand is drying from the bottom surface only the rate of drying remains constant until the pendular state has been reached throughout the entire layer. The pendular state starts first at the top surface, gravity maintaining the bottom surface wet until the pendular state has been reached through the sand above. For

Table V—Annual Cost of Recirculating Air

y Fraction Recirculated	Time Min.	Length Feet	Investment	Radiation Losses	Power	Preheating	Evaporation	Total
0	122	98.5	\$1231	\$215	\$290	\$2740	\$2600	\$7076
0.2	131	106	1335	231	312	2200	2600	6678
0.4	159	129	1612	282	380	1650	2600	6524
0.5	186	150	1880	326	441	1370	2600	6617
0.55	197	159	1990	346	468	1230	2600	6634
0.6	246	199	2490	433	585	1100	2600	7218

Nomenclature*

A = area, sq. ft.
E = equilibrium moisture content, lb. per lb. dry stock
F = free moisture content, lb. per lb. dry stock
G = mass velocity of air, lb. per min.-sq.ft.
H = humidity of air, lb. per lb. dry air
ΔH = $H_s - H_a$
h_o = humidity of fresh air, lb. per lb. dry air
$\%h$ = percentage humidity of air
L = thickness, ft.
L = one-half thickness in feet when drying from two surfaces
p = vapor pressure
R = rate of drying, lb. per hr. - sq. ft.
r = ratio of rate of dry air to rate of dry stock
t = temperature, deg. F.
T = total moisture content, lb. per lb. dry stock
V = air velocity, ft. per sec.
W = weight of water, lb.
y = fraction of air recirculated
θ = time, hr.
θ' = time, min.

Subscripts

o = entering air, or entering stock
l = leaving air, or leaving stock
a = main stream of air
s = surface of evaporation
w = at wet bulb temperature

* Metric units are used in problem IV.

this reason the time of drying will be less when drying from the bottom surface than from the top with air blowing at the same conditions over the surface involved.

Problem—Calculate the time required to dry completely a layer of sand 6 cm. thick for: (a) top drying; (b) bottom drying; and (c) top and bottom drying.

Fig. 5 gives the drying rate curve. The non-drying surface is well insulated. The sand is initially at the wet bulb temperature of the air. Air is blown over the drying surface at average conditions of 60 deg. C., humidity 10 per cent and velocity of 10 m. per second. The sand is initially saturated with water, 35 per cent (dry basis). The dry sand has a density of 1.38 grams per cc.

The rate of drying during the constant rate period may be expressed by the equation[1]:

$$R_1 = \frac{dW}{Ad\theta} = 0.00433\ V^{0.8}\ \Delta p \text{ grams per hr.-sq.cm.}$$

Where V is air velocity in meters per second and Δp is vapor pressure difference, surface to air stream, in mm. of mercury.

Solution—At 60 deg. C., 10 per cent humidity, the wet bulb temperature of air is 30.6 deg. C., and the dew point is 20.6 deg. C.

Vapor pressure at 30.6 deg. C. = 32.6 mm.Hg.
Vapor pressure at 20.6 deg. C. = 18.0 mm.Hg.
Δp = 14.6 mm.Hg.

Hence

$R_1 = 0.00433\ (10)^{0.8}\ (14.6) = 0.40$ grams per hr.-sq.cm. The value of R_c for a layer 6 cm. thick = 0.126 grams per hr.-sq.cm.

The limiting moisture contents, Fig. 5, are:

w_s = 35 per cent initial value, saturated
w_B = 21.4 per cent at end of constant rate period, 6 cm. layer
w_c = 4.75 per cent at beginning of pendular state, 6 cm. layer
w_e = 0 per cent at end of complete drying

Dry sand per sq.cm. of area = 1.38 × 6 = 8.28 grams

(a) For top drying:

Water removed during

constant rate period
= 8.28 (0.35 − 0.214) = 1.13 grams
first falling rate period
= 8.28 (0.214 − 0.0475) = 1.38 grams
final falling rate period
= 8.28 (0.0475) = 0.39

Average rate of drying during the

first period = 0.40 grams per hr.-sq. cm.
*second period = log mean of 0.40 and 0.126 = 0.238 gr. per hr.-sq. cm.
*final period = log mean of 0.126 and 0.01 = 0.046 gr. per hr.-sq. cm.

Time of first period $= \dfrac{1.13}{0.40} = 2.82$ hours

second period $= \dfrac{1.38}{0.238} = 5.80$ hours

third period $= \dfrac{0.39}{0.046} = 8.48$ hours

17.10 hours

The total time for top drying is therefore 17.10 hours.

[This solution should replace that given by Ceaglske and Hougen, in *Trans. A. I. Ch. E.*, 33, 309, (1937) and *Ind. Eng. Chem.* 29, 813, (1937)]

(b) For bottom drying:

Water removed during

constant rate period
= 8.28 (0.35 − 0.0475) = 2.51 grams
final rate period
= 8.28 (0.0475) = 0.39 grams

Time of constant rate drying

$= \dfrac{2.51}{0.40} = 6.28$ hours

final period = 8.48 hours

Total drying time = 14.76 hours

The time required for bottom drying is thus 16 per cent less than for top drying.

(c) For both top and bottom drying:

Time of first period

$= \dfrac{1.13}{0.4 + 0.4} = 1.41$ hours

Time of second period

$= \dfrac{1.38}{0.4 + 0.238} = 2.16$ hours

Time of third period

$= \dfrac{0.39}{0.046 + 0.046} = 4.25$ hours

Total 7.82 hours

The answers to the problem are therefore 17.10, 14.76 and 7.82 hours. Of course combined top and bottom drying gives the quickest results. However, as was pointed out at the beginning of this article, there are many factors to be considered to determine which method is most practical from an economic standpoint.

Fig. 4—Drying rate curves for sand in layers of different thicknesses

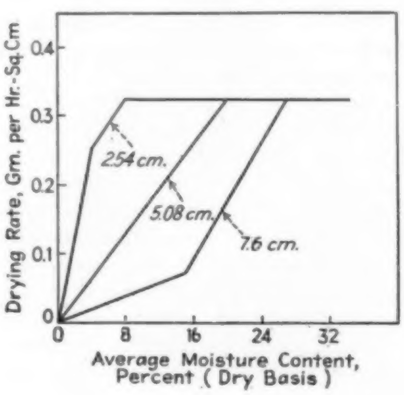
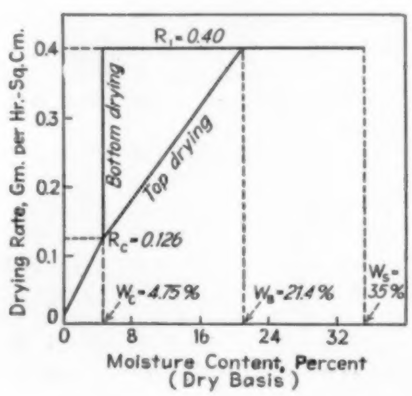


Fig. 5—Drying rate curve for a layer of sand 6 cm. thick



References

1.—Ceaglske, N. H., and Hougen, O. A. *Trans. A.I.Ch.E.* 33, pp. 283-312 (1937).
2.—Walker, Lewis, McAdams and Gilliland, "Principles of Chemical Engineering," McGraw-Hill Book Co. (1937)

* In this illustration the falling drying rate curves are straight lines so that average drying rates are equal to the logarithmic mean values. The final rate at zero moisture content is 0.01.

Considerations in Valve Lubrication

Lubrication of plug valves is a highly specialized field, differing basically from the needs of other fields of industrial lubrication. A knowledge of its fundamentals is especially important in process industries where such valves are widely used.

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It is commonly assumed that the lubrication of plug valves is essentially similar to the lubrication of other equipment with moving parts wherein lubricants are used principally for the purpose of reducing friction. As a result valve "lubricants" are frequently appraised by false standards and by comparison with other types of lubricants used for shaft bearings, gears, thrust bearings, etc., which are intended for entirely different purposes.

Lubricated valves are almost universally the plug cock type, the vast majority incorporating the tapered form of plug and seat. The plug cock form of valve is particularly adapted for corrosive and erosive services, owing to the fact that when in the fully open or closed position the contact surfaces of the seat and plug are not exposed to the flow of line fluid. Also the use of pressure lubrication in the plug cock makes this form of valve practical for large sizes, many lubricated plug cocks having been installed on 16-, 24-, and 30-in. pipe lines.

The lubricant used in a lubricated tapered plug cock performs a number of functions which, in order of importance, may be listed as follows:

1. Effects a plastic seal between the sliding contact surfaces of the valve to prevent leakage of the line fluid and to prevent infiltration of foreign matter between these surfaces.

2. Furnishes a fluid medium for lifting the plug from its seat, both to provide a space for the renewal of the lubricant film and to free the plug from its seat if corroded and frozen together.

3. Effects easy operation of the valve by lubricating the sliding contact surfaces and reducing the friction between them.

4. Provides a protection for these surfaces so that the original surface finish is not marred by corrosion which would increase the turning effort and also permit leakage.

The lubricant is generally applied to lubricated plug cocks in the form of small cylindrical solid sticks which are inserted in a chamber in the valve stem and compressed by means of a lubricant screw.

Sometimes the lubricant is applied by means of a grease gun, in which case the lubricant compressor screw is replaced by a lubricant nipple and bushing, and the gun connected by means of a bayonet or button-head fitting. In both bases the lubricant is introduced and distributed under pressure to the surfaces to be lubricated. A sufficient amount of air is entrained and compressed between applications of the lubricant to serve as a means for maintaining the pressure and continuing the lubricant feed to the sliding surfaces.

Various mechanical means are provided for limiting the thickness of the lubricant film and returning the plug to its seat as the plastic film is slowly dispersed. Also, various methods of distributing the lubricant by means of lubricant channels cut in the surfaces of the plug and body of the valve are used by different manufacturers. Generally speaking, these are designed to spread the lubricant in the most effective manner that will perform the several functions mentioned above.

It will be apparent that in order to obtain the most effective lubricant film, this should be limited in thickness to secure the maximum sealing effect for any given viscosity. The film must also be perfectly continuous for the same reason, for if continuity of the lubricant film is not obtained, the line fluid will find its way through the open channels in the film. Thus, if the characteristics of the lubricant are such that it does not provide sufficient wetting power to adhere to the metal, or if the viscosity is so high that when applied under pressure it will channel and escape into the pipe line without properly distributing itself, a proper sealing effect will not be obtained between the sliding metal surfaces.

It will also be observed that in the areas where the lubricant channels, cut in the surfaces of the plug or body, are in contact with the adjacent metal surfaces, practically no sealing effect is obtained from the lubricant, since the depth of the lubricant film in these channels is too great adequately to resist displacement under line pressure. These channels serve only to distribute the lubricant uniformly over the sliding metal surfaces so as best to obtain an effective seal. The areas where this seal is really obtained are those areas adjacent to the distributing channels where the thickness of lubricant film is such that it satisfactorily resists displacement by line pressure.

While the viscosity of a valve lubricant is easily recognized as contributing directly to its resistance to displacement according to well known laws of sinuous fluid flow, another factor is of prime importance, especially manifested in very thin valve lubricant films. This is the quality of adhesiveness to the metal surfaces with which it is in contact. While the cohesiveness of the molecules of the lubricant may be regarded as determining the degree of viscosity, the adhesiveness of these molecules to the metal surface also is of importance in determining the sealing value of the lubricant. This characteristic is also apparently contingent upon its surface tension or wetting power, although it is hard to think of a material as having a high viscosity as well

as a low surface tension. From a practical aspect, this problem presents difficulties at times, since the type of valve lubricant required for resisting solubility in the line fluid of a given service, as for instance that of petroleum distillates, must also show satisfactory adhesion to metal surfaces which may already be wetted by the oily petroleum distillates.

In order to maintain a satisfactory lubricant film and perform the above-mentioned functions of sealing against leakage, jacking the plug from its seat, lubricating the sliding metal surfaces, and affording protection against corrosion of the metal surfaces, the lubricant itself must possess satisfactory characteristics which are stable under the service conditions in which it is used. It must obviously be resistant to solubility in the line fluid and chemically resistant to decomposition by this fluid. If it is to be used at elevated temperatures, the lubricant must also be resistant to vaporization, to thermal decomposition and the increased chemical activity of the line fluid, as well as to its increased solvent power.

The effect of temperature upon lubricants used for the lubrication of gears or ordinary rotating shafts in journals is mainly that of changing the viscosity of the lubricant, but only in rare cases does the lubricant also have to withstand the action of strong solvents or reactive chemicals as well, which is often the case with valve lubricants. Sometimes the valve lubricant is called upon also to withstand the action of several different types of line fluid consecutively, as for instance oil and steam, or acids, alkalis, water, and organic solvents in turn, as in oil refining operations.

It is worth noting also that the manner of lubricating a rotating shaft in a bearing is different from that of a tapered plug cock. The rotating shaft does not contact the inside of the bearing around the entire periphery, but lies, in effect, eccentrically in the bearing. This permits the lubricant to be continuously drawn between the areas in rubbing contact. In the lubricated tapered plug cock, the lubricant is forced between the plug and seat and maintained there continuously by mechanical means. In this respect the problem of plug cock lubrication is analogous to that of a thrust bearing.

It should be kept in mind that the temperatures to which plug cock lubricants are frequently subjected may fall in the range where decomposition of the lubricant is the principal factor. On the favorable side is the fact that a much wider variety of materials are available for the manufacture of these lubricants, since the matter of oiliness or reduction of friction is not the prime factor which it is in bearing lubricants. Also, since valve lubricants, under actual service conditions, are operated under the superimposed pressure of the line fluid, this is a favorable factor in regard to the dissipation of the lubricant by vaporization. A common valve lubricant constituent, for instance, which has a boiling point of 575 deg. F. under atmospheric pressure will not boil below 750 deg. F. under a line pressure of 350 lb. per sq.in. The line pressure is a factor which should always be considered when evaluating valve lubricants for service conditions.

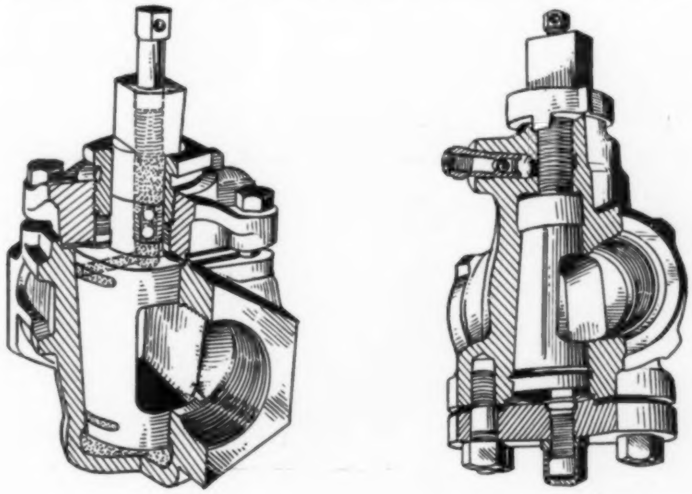
Another factor of practical importance which must be considered in regard to the actual operating temperature of valve lubricants is that the temperature of the line fluid itself is not an exact criterion of the operating temperature of the lubricant in the valve. Unless the valve is lagged with some insulating material, a considerable amount of heat is dissipated from the valve body by radiation and convection into the atmosphere. The rate at which this heat is dissipated will depend upon the temperature of the surrounding air, its rate of motion, the condition of the metal surface, etc., and this is a fairly constant rate. However, the rate of heat input from the line fluid to the valve metal is dependent largely upon the character of the line fluid. If this is a condensing vapor or a flowing liquid, the rate of input is obviously much higher than if the line fluid is a non-condensing gas. The actual valve temperature, which is a mean somewhere between the temperature of the line fluid and the temperature of the outside atmosphere, will therefore be considerably lower if the line fluid is a fixed gas rather than a condensing vapor or a flowing liquid, and therefore the temperature at which the valve lubricant will have to operate will also be lower than the line fluid.

Within the operating temperature range recommended for a valve lubricant it is of course desirable to maintain as flat a temperature-viscosity curve as possible, provided this is permitted by the other chemical and physical characteristics required of the lubricant. A high viscosity index means more uniform sealing qualities throughout its working temperature range with a minimum of mechanical adjustment required. Generally speaking, the solid materials used in the compounding of valve lubricants should have a softening point as far below the melting point as possible, or in other words a wide plastic temperature range.

Besides the conventional mineral oils and soaps used in compounding ordinary cup greases, many other materials are used in the manufacture of valve lubricants. These include vegetable and animal oils, fats, waxes, asphalts, synthetic oils and waxes, graphite, resins, glycerine, alcohols, and various inert materials sometimes used for fillers. This is a fertile field for inorganic lubricants and plastics, and it is to be expected that in the future much progress can be anticipated in this direction.

Left—Standard type of lubricated plug valve showing lubricant chamber, screw and passages

Right—Nordstrom Hypreseal valve for extreme pressures, in which lubricant pressure is applied directly to the smaller end of the plug



Modern Chlorine Practice

Back in 1931* Chem. & Met. *published an article on electrolytic cells. By revision of the performance data and operating characteristics presented then and by discussion of several additional types of cells, Dr. Mantell has brought his story right up-to-date.

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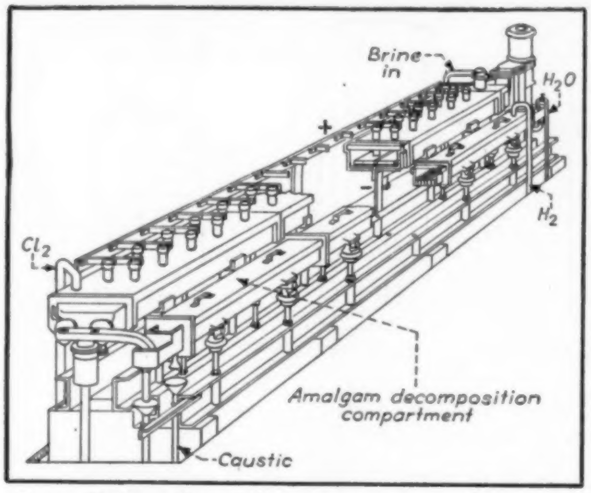
SINCE the last review by this author on electrolytic cells (*Chem. & Met.* 38, 88, 1931) the total capacity of chlorine production has jumped from 230,000 to more than 500,000 tons. Sixty-three thousand tons of this capacity is in 15 plants of the pulp and paper industry, while 404,000 tons is in strictly electro-chemical plants. Of these plants, 24 are producing chlorine and caustic, either sodium hydroxide or potassium hydroxide, while one makes chlorine and sodium metal. Of the total chlorine production, approximately 21 per cent is used for bleaching pulp, 5 per cent for textiles, about 60 per cent in the manufacture of chlorinated hydrocarbons, ethylene glycol, chlorinated naphthalene, refrigerants and bromine, 6 per cent in sanitation, and 8 per cent in all other uses. Practically all of the chlorine is produced in electrolytic cells which consume about 3,000 kw.-hr. per ton of chlorine, while mechanical power and energy for pumping, compression, evaporating material, handling, and lighting bring the total energy up to about 3,400 kw.-hr. per ton of chlorine. While in 1929 electrolytic caustic constituted only about one-third of the total caustic production, today the figure is nearer one-half as the result of expanding markets for chlorine. At the present time the cell capacity is believed to be in the neighborhood of 1,500 tons of chlorine per day.

The commercial cells have assumed a large number of forms. In general there are two classes, the first represented by those units employing circulating liquid electrodes of mercury and represented by the Castner which in its original form circulated the intermediate mercury electrode by rocking the cell, the Sorenson which employs a circular wheel and is operated by a paper company, and the large Krebs which is begininng to find application in the United States as the result of its performance of 275 tons per day capacity in various parts of the world. In this unit the mercury is circulated by Archimedean screws or pumps. Currently the mercury in the latter two cases is the cathode in the cell and is circulated from the electrolyzing chamber to a denuding or decomposing section without functioning as an intermediate electrode. The second class is the diaphragm cell in which all types have graphite anodes, iron or steel cathodes and diaphragms mainly of asbestos. They are subdivided according to the arrangement of the diaphragm into those in which this portion of the cell is submerged

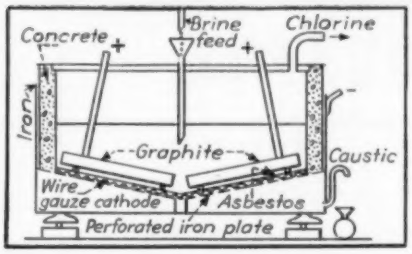
Performance and Characteristics of Electrolytic

Item	Kind of Cell	Sorensen	Krebs Mercury Type	Le Sueur	Townsend	Giordani-Pomilio	Hooker Type "S"
1	Shape of cell	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Square
2	Voltage across cell	4.2	3.85–4.0	4.0	4.55	3.5–4.2	3.28–3.45
3	Current per cell, amperes	1,300	3,250–15,000	2,400	5,000	3,000–3,200	5,000–7,000
4	Current density, anode, amp. per sq. in.	0.80	1.03–1.68	0.17	1.23	0.45–0.52	0.318–0.446†
5	Current density, cathode, amp. per sq. in.	0.80	0.97–1.61	0.26	0.645	0.32–0.39	0.268–0.377†
6	Current efficiency of cell, per cent	90–95	94–96	85	96	90–96	94–95.5
7	Energy efficiency of cell, per cent	48–52	50–60	49	48.5	52–58	64–66
8	Pounds NaOH per kw.-hr	0.70	0.68–0.75	0.70	0.695	0.77	0.91–0.94
9	Pounds chlorine per kw-hr	0.63	0.6–0.67	0.62	0.617	0.66	0.84
10	Anode material .*	Graphite	Graphite	Graphite	Graphite	Graphite	Graphite
11	Cathode material	Mercury	Mercury	Iron wire netting	Steel and wire screen	Perforated iron sheet	Steel and wire screen
12	Diaphragm material			Asbestos paper	Asbestos paper	Asbestos cloth and paper	Deposited asbestos
13	Cell container material	Concrete lined cast iron frame	Iron, ebonite	Iron, cement lined	Concrete and steel	Cement	Concrete and steel
14	Anode life, days	600		5 years, avg.	350	300–500	350–600
15	Average operating period of cell, days	28		6 months	40‡	90–300	100–300‡
16	Raw material	NaCl	NaCl	Brine	Brine	Saturated brine	Brine
17	Concentration of cathode alkali, gm. per l.	To 50 per cent	350–650	110–125	136	120–180	135
18	Salt concentration, cathode alkali, gm. per l.	Trace	Trace	80 anodes	14–16 per cent	110–150	14–15 per cent
19	Size of anode	9 anodes 20"x9"x2"	1¼"x6"x18"	3"x4"x23"	18 anodes	1,300x200x75 mm.	90 anodes [illegible]
20	Size of cathode	Surface of mercury approximately the same as anode		Active surface 63 sq. ft.	1¼"x12¼"x18" Active surface 54 sq. ft.	1,000x3,300 mm.	1¼"x6¼"x18" Active surface 129 sq. ft.
21	External measurements of cell	5'x6'x1'		16.6'x5'x1.7'	1'8¼"x16'2"x5'4"	360x150x19 cm.	4'6"x4'11¼"x3'3"

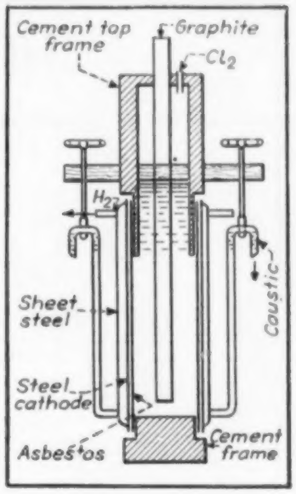
* Calculated from entire anode or cathode surface. ‡ Diaphragm run, days.



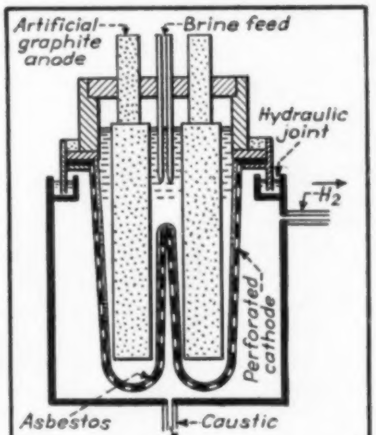
Large Krebs cell in which mercury is amalgamated with sodium and the amalgam decomposed with water



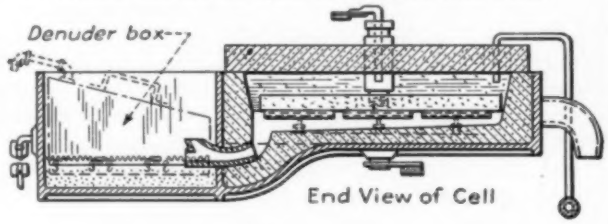
This type of cell, the Le Sueur, was used in the first U. S. electrolytic plant

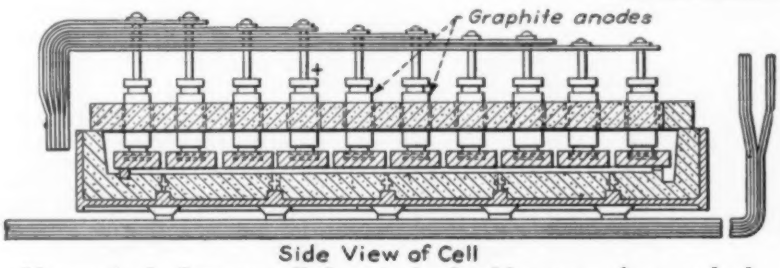


Note the high anodic chamber of this Giordani-Pomilio cell



Left—Krebs diaphragm cell, anode box on top is made of refractory material





Mercury in the Sorensen cell above is circulated by means of a cup wheel

in the electrolyte and arranged horizontally as in the LeSueur unit employed in the first electrolytic plant in the United States and still operating. A second subdivision is that of the vertical submerged diaphragm whose current examples are the rectangular tall Townsend which formerly employed kerosene oil in the

Cells for Chlorine and Caustic Soda

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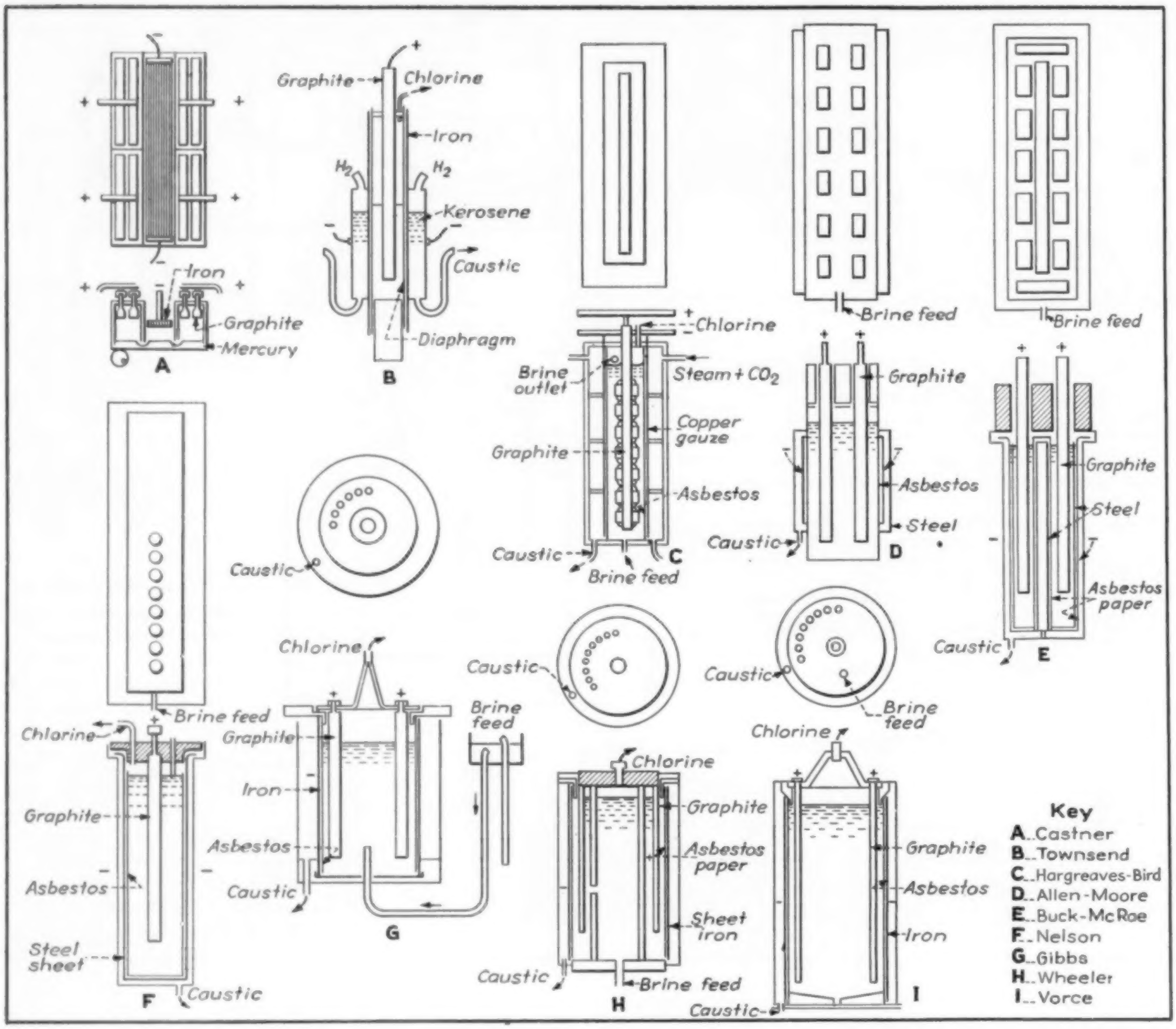
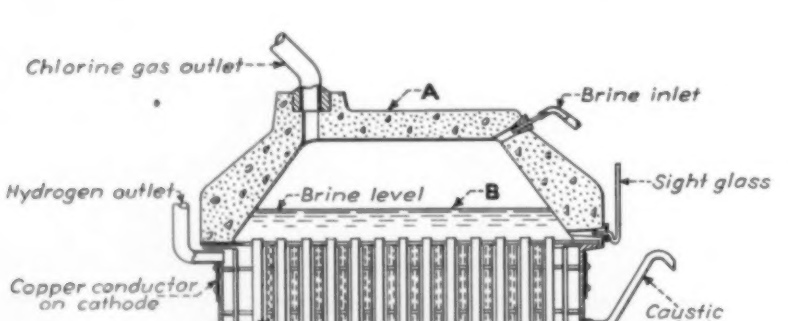
Item	Hargreaves-Bird	Allen-Moore	Buck-McRae	Krebs Diaphragm Type	Nelson	Gibbs	Vorce	Wheeler
1	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular	Cylindrical	Cylindrical	Cylindrical
2	4.2	3.3–3.80	3.6	3.3–3.7	3.75 avg.	3.43	3.5–3.6; 3.7	3.6
3	3,000	1,200–1,500	1,500	500–6,000	1,000	800	950–1,000; 1,500	1,200–1,600
4	0.03	0.22–0.406†	0.42	0.4	0.30	0.12*	0.14*, 0.34†	0.14*
5	0.21	0.24–0.31		0.39	0.34	0.31*	0.35*, 0.5†	0.37*
6	90	90–95	92–97	93–94	93–95	92–95	94–96	96–99
7	50	58–63	58–64	58–66	56–60	62	61–62	60–62
8	0.914 (Na_2CO_3)	0.750–0.905	0.83	0.84–0.95	0.76	0.83	0.86	0.83
9	0.62	0.665–0.8	0.74	0.75–0.83	0.67	0.74	0.79	0.74
10	Graphite	Graphite	Graphite	Graphite	Graphite	Graphite	Graphite	Graphite
11	Perforated steel	Perforated steel	1/16" perforated steel plate	Iron	Perforated steel sheet	Steel	Perforated steel	Special weave wire cloth
12	Composition	Asbestos paper	Asbestos paper	Special asbestos paper	Asbestos paper and cloth	Asbestos paper	Asbestos paper	Asbestos paper
13	Cast iron casing acidproof brick lining	Steel and concrete	Steel and concrete	Iron, fibro-cement	Steel tank, asbestos board and slate gas dome	Steel and cement composition	Steel and cement composition	Quartz-asbestos-cement, asphalt treated
14	750	425–900	300–360		900	600	600–900	480–600
15	360	360 avg.	120	9–10 months §	180–360	120	120–180	150–200§
16	Saturated brine	Brine	NaCl	NaCl	NaCl	Saturated brine	Saturated brine	Hot brine
17	170 (Na_2CO_3)	90–110	110	100–130	100	120	90–105	110–120
18		170–200	170	130–170	15.2 per cent	140–170	16 per cent	140–170
19	72 anode plates 16½"x9"x2"	Active surface 3,696 sq. in.	Active surface 3,600 sq. in.		14 anodes 4"x4"x17"	3"x2"x36	24 anodes 2"x2"x36"	28 anodes 2"x2"x32"
20	10'x5'	6,181½ sq. in.			77½"x43½" U-shaped	36"x72"	22" diam.x34"	34"x80"
21	11'6"x7'x1'6"	8'6"x1'2½"x3'	4'5¼"x1'1¼"x2'11½"		6'6"x11½"x2'10"	26" diam. x 36"	26" diam. x 42"	29"x36"

† Calculated from "active" anode or cathode surface.

§ Diaphragm life, days.



Diagrammatic sketches of nine different types of electrolytic cell, both top and front views and given for eight cells



Essential characteristics of the Hooker type "S" electrolytic cell for making caustic soda and chlorine are shown in this diagram. The three parts are designated as *A*, concrete top; *B*, cathode assembly; and *C*, concrete bottom

caustic chamber; the somewhat similar unit of Giordani-Pomilio employed at Celulosa Argentina; and the cubical shaper Hooker described recently. (*Chem. & Met. Eng.*, **45**, 354, 1938). A third subdivision of diaphragm cells employing circulating electrolytes in which units are rectangular in shape has as examples the Hargreaves-Bird used by the paper industry for chlorine and carbonate as the result of the introduction of carbon dioxide which reacts with caustic; the Allen-Moore; the somewhat similar Buck McRae with its central diaphragm and cathode, formerly employed by the paper industry; the Krebs with a somewhat different arrangement of the same idea; and the Nelson. The last subdivision consists of a group of designs employing vertical free diaphragms in relatively

(Please turn to page 170)

Your Plant NOTEBOOK

HOW TO USE AVAILABLE RECORDERS FOR CONTINUOUS RECORDS WITH INDICATING pH METERS

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It is frequently desirable to obtain a continuous record of the pH change of reactions that require the use of glass electrodes. The equipment required for recording such data is often too expensive for general plant and laboratory use. The following describes an inexpensive pH recorder that has been used with a battery-operated Beckman industrial type pH meter and either a recording millivoltmeter or recording potentiometer of the type used for pyrometers, recording flue gas analyzers, etc. Such a pH recorder with shielded glass electrodes has been in satisfactory continuous use for 16 months. For such continuous use, however, an a.-c. operated recording pH meter is to be recommended since otherwise the batteries require frequent renewal. This method does not apply to the laboratory potentiometer-type glass-electrode pH meter.

Shielded electrodes having long leads can be used in either a flow channel or installed in a holder that can be immersed in a reaction vessel. Although the electrodes supplied with the pH meter may be used in this manner, special electrodes, flow channels, and immersion assemblies are available for these applications.

The reading of pH on the industrial type pH meter is indicated on a milliammeter which is uniformly graduated in pH units. In the Beckman instrument one scale covers the range of pH 0–7 and the other scale covers pH 7–14. It is ordinarily necessary to turn a switch when the pH goes above or below pH 7, since the pointer moves to the left of the end of the scale. No switching is required when using the recording meter over a limited range.

In the following the milliammeter pH indicator of the industrial pH meter will be referred to as the milliammeter.

There is no current flowing in the milliammeter at pH 7 and approximately 1 ma. flows at pH 0 or pH 14, the direction reversing at pH 7. It is possible to use a zero center recorder to cover the range above and below pH 7. A zero center recorder can be made by merely shifting the mechanical or electrical zero point to a convenient point on the scale.

For convenience, a radio phone jack may be connected to the pH meter into which the recorder may be plugged at any time. It is desirable to use shielded wire for the leads to the recorder.

Typical hookups of an industrial pH meter with recording equipment

Fig. 1—Hookup of industrial pH meter with a milliammeter

Fig. 2—Hookup of industrial pH meter with standard-cell potentiometer

Fig. 3—Hookup of industrial pH meter with meter-standardized potentiometer

Key

M = Milliammeter in industrial pH meter
M_1 = Milliammeter or - voltmeter recorder
M_2 = Standardizing milliammeter, 0–1 ma.
J = Radio jack
P = Radio plug
G = Galvanometer
R = 200-500 ohm potentiometer
R_1, R_5 = 1,000 ohm radio potentiometer
R_2, R_3 = Potentiometer current control
R_4 = Potentiometer slide wire
R_6 = 50 ohm potentiometer
R_7 = 1,000 ohm resistance
- - - = Original connections to meter

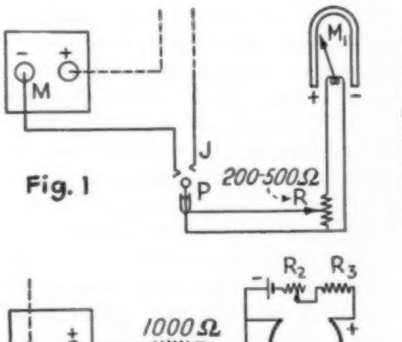


Fig. 1

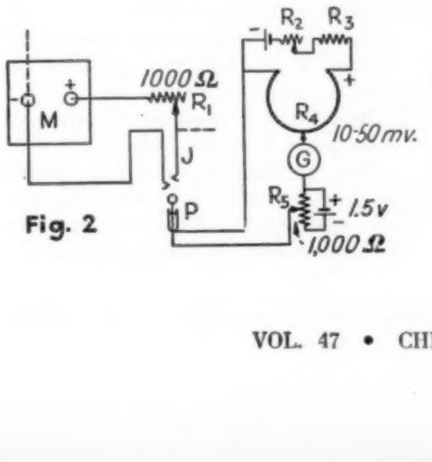


Fig. 2

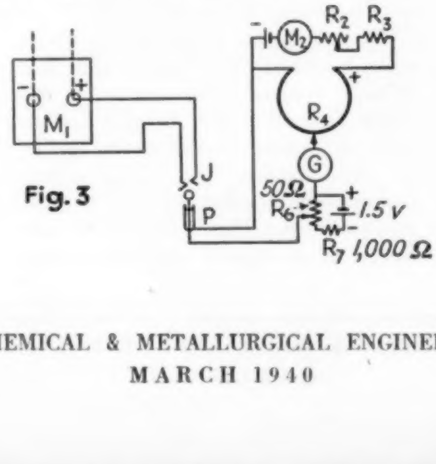


Fig. 3

Millivoltmeter or Milliammeter Recorder

A common type recorder available in many plants and laboratories is the recording millivoltmeter or milliammeter commonly used on recording pyrometers, thermal conductivity gas analyzers, and d.-c. recording voltmeters or ammeters. This type of instrument consists of a sensitive milliammeter generally equipped with shunt and series resistors. If the resistors are disconnected, the meter element may have a full range of less than 1 ma. If it is then connected in series with the meter of the pH meter the current through the two instruments will be the same. The deflection of the recorder will depend on its milliampere sensitivity. If the full scale range is less than 2 ma., the full swing of the instrument may be used.

Fig. 1 shows the wiring diagram for use on this type of recorder. For example, an Englehard recorder formerly used on a flue gas analyzer had a full scale sensitivity of 0.01 ma. It was necessary to shunt the coil of this meter with a 500-ohm radio potentiometer to provide the desirable recording range and coil damping. The scale of the recorder was graduated in 100 divisions. The pointer was set at 70 for a mechanical zero by turning the suspension, since at pH 7 there is no current flowing in either meter. The adjusting knob on

the pH meter was turned until the pH meter read pH 10. The shunt potentiometer, R, on the recorder was then adjusted until the recorder read 100. The recorder then followed the readings of the pH meter. The recorder continued to read correctly after the pH meter went below pH 7 at which time the milliammeter pointer moved to the left of the scale.

It is necessary to keep the resistance of this type of meter as low as possible since resistance added to the milliammeter circuit causes a slight error in the pH reading. This error is proportional to the deflection of the meter. Such errors can be minimized by standardizing the combined meter and recorder at the critical pH point. For example, if it is desirable to maintain a pH value of 10, the instrument should be standardized with a 10 pH buffer.

It is sometimes desirable to make a correction curve over a wide range. This can be done easily by checking the meter and recorder at several points with standard buffers and plotting a correction curve.

Recording Potentiometer

A recording potentiometer of the type used for pyrometers, recording ammeters, etc., can be adapted by making use of the voltage drop across the milliammeter. The voltage drop across the milliammeter in the Beckman Model M pH meter for a change of 7 pH units is 11.5 mv. for the older type instruments and 35 mv. on the newer type. This makes a change of 1.64 mv. and 5 mv. per pH unit respectively. This drop can be measured readily by connecting a potentiometer across the milliammeter, deflecting the milliammeter to full scale by the adjusting knobs and measuring the millivolt drop.

Since there are so many different ranges on potentiometers that have been made for various applications, the recorder must be adapted to read either in arbitrary units and calibrated, or altered to read directly in pH units.

Fig. 2 shows the manner by which a recording potentiometer that uses a standard cell may be adapted to read in pH units.

Fig. 3 is an adaptation of a recording potentiometer using a series meter for standardization of the slide wire instead of the standard cell. The range of this type potentiometer can be changed over wide limits by changing the current flow through the slide wire. By first determining the resistance of the slide wire the necessary current to produce the necessary voltage drop can be calculated by Ohm's law.

If, for example, in Fig. 2 a potentiometer covers the range of 0–20 mv. over a chart range of 0–20, a rheostat should be connected in series with the milliammeter to increase the voltage drop applied to the potentiometer. A series compensating battery and 1,000-ohm potentiometer are connected in series with the pH meter and potentiometer to provide a potential to deflect the potentiometer to 7 on the chart when the pH meter reads 7.

The adjustments with circuits of Figs. 2 and 3 should be made in the following order:

1. Set the milliammeter to pH 7.
2. Set the series compensating potentiometer to zero.
3. Deflect milliammeter to pH 12 (5 units).
4. Adjust rheostat R_1 (Fig. 2) in series with milliammeter or R_2 (Fig. 3) to potentiometer reading 5.
5. Shift series compensating potentiometer to recorder reading 12.
6. Standardize the pH meter in customary manner.

The recorder will now follow the indicating milliammeter when set on the 7–14 range. It will indicate correctly even though the milliammeter swings to the left of pH 7.

These same principles may be adapted to remote indicators.

A convenient set of buffers for standardizing a pH meter can be readily prepared by using the formulas for McIlvaine's Standard Buffer Solutions. These formulas may be found in standard chemical handbooks.

Simple Alarm Switches

According to *Rock Products* a simple switch for operating an alarm to call attention to the loss of feed to a belt conveyor can be made by pivoting a mercury switch to which an arm, the end of which is shod with rubber, is attached. The rubber shoe, riding on the conveyor load, normally holds the switch open. Loss or serious diminution of the load permits the arm to drop and closes the switch, thus sounding the alarm.

Another simple alarm device, which was described by *Engineering and Mining Journal*, was used by the Santa Cruz Portland Cement Co. to warn of failure of the water supply to the jackets of compressors. Jacket water discharged from a pipe into a funnel. The added alarm consisted of a second smaller funnel which was supported inside the first on a lever arm balanced on a fulcrum, with a mercury switch mounted on the arm and connected to a signal. The weight of water flowing through the smaller funnel would ordinarily keep the switch open, but decrease in the water flow would permit overbalancing of the funnel and sounding of the alarm.

MODERN CHLORINE PRACTICE

(*Continued from page* 168)

small cells which are cylindrical in shape, and represented by the units of Gibbs, Wheeler, and Vorce. These cells are illustrated in the accompanying diagrams, plant operating data are given in Table I.

Standard practice in chlorine plants, irrespective of the type of cell, calls for saturated purified salt brine free of heavy metals and as free as possible of alkaline earth metals or materials which would tend to clog diaphragms. For mercury cells the brine is usually chlorinated. Analysis of the operating data indicates that the mercury cells are capable of handling high concentration caustic liquors free from salt, while diaphragm cell caustic liquors contain a greater salt than caustic concentration. Diaphragm cell effluents need to be evaporated for removal of salt as well as concentration of caustic liquors. Mercury cell effluents are concentrated enough so that they may be shipped directly or readily converted to solid caustic without salt contamination.

The different cells in the many plants operate under widely varying conditions of power cost, local factors, labor rates, plant location, raw materials, and are each influenced by these factors so that direct comparisons of different cells on an energy basis is unwarranted. In plants operating at low current densities, anode lives are long and anode expense low; other units at higher current densities due to space demands or other factors, show shorter anode life. In some plants loads vary, in others they are maintained at a constant level. Some operators balance diaphragm maintenance against cost of electrolyte purification. From an economic viewpoint some plants can justify more frequent changes of anodes than can others.

Innumerable designs of chlorine cells have been proposed, but only a few variants of relatively simple mechanisms have withstood the test of continuous industrial practice under competitive conditions.

Series A No. 2

Chem. & Met. Report

ON

Plant Lubrication

TO PLANT MANAGERS, SUPERINTENDENTS AND CHEMICAL ENGINEERS

ONE OF THE COMMON and fundamental problems of all industry is the control of friction. Plant lubrication is an important part of that problem. In the chemical industry it is an especially hard part because the chemical plant has all the general factors affecting lubrication *plus* a good many specialized factors to provide complications.

The chemical engineer must necessarily take a hand in the solution of these lubricating problems because, in many instances, he alone can evaluate some of these complicating factors. However, he seldom solves the whole problem. He must work hand in hand with the "lubrication engineer," the specialist whose job is eliminating friction.

Our purpose here is not to make lubrication engineers out of chemical engineers, but rather to provide the chemical engineer with a working knowledge of the fundamentals of lubrication so that he may cooperate more effectively in the two-man job of lubricating a chemical plant.

CHEMICAL & METALLURGICAL ENGINEERING
VOL. 47, No. 3, March 1940

TITLE OF REPORT Chemical Plant Lubrication

TO Plant Managers, Superintendents and Chemical Engineers

FROM Editors of Chem. & Met.

DATE March 1940

INTRODUCTION and SUMMARY

CHEMICAL PLANT LUBRICATION may be analyzed in several ways: Your editors have chosen to divide the subject roughly into four parts whose boundaries are not clearly defined. However, an effort has been made to point out the places where overlapping occurs.

ELEMENTS OF LUBRICATION—In this part the function of lubrication is defined together with the theoretical aspects of how that function is performed. Because the section is designed to show why we lubricate, most chemical engineers will find parts of it elementary; however, these have been included for the sake of presenting a complete overall picture.

PROPERTIES OF LUBRICANTS—To select the right lubricant for a given job requires a knowledge of the desirable (and undesirable) properties of lubricants. Here the sources of lubricants are discussed—mineral, animal, vegetable and other—together with the outstanding properties of lubricants and the tests for them. Significance of viscosity, viscosity index, demulsibility, carbon residue, flash point and others are included.

APPLICATION OF A LUBRICANT—A discussion of thin-film and fluid-film lubrication is included here. Also methods of lubricating and the principal types of lubricating devices, their advantages and disadvantages, and characteristics of a good lubricator are discussed. Storing and handling of lubricants are, of course, an integral part of their proper application.

CHEMICAL FACTORS IN LUBRICATION—This part of the report deals with those specialized problems that occur only in the chemical industry where the usual lubricating procedure does not apply. The presence of corrosive or solvent chemicals, of poisonous gases, of unusual materials of construction, of extreme conditions of temperature and pressure, represents some of these conditions. Exacting requirements of purity of product is another factor.

Because space limitations forbid the discussion of so broad a subject in adequate detail for some purposes, we have appended a condensed bibliography to aid readers who wish to pursue the subject further.

Part I—Elements of Lubrication

IN ANY STUDY of lubrication, the first question answered should be "What is lubrication?" because upon the answer depends all further discussion. According to lexicographers, lubrication is the act of making something smooth or slippery. To engineers it is more specifically the application of a substance which promotes smooth operation of mechanical equipment and retards friction.

Friction has always been a two-faced Janus—sometimes working for and with man, sometimes against him. Because of this fact man depends for his very existence on his ability to control friction—to take advantage of its help and to lessen its hindrance. His efforts in this latter direction come under the heading of *lubrication* and to know what this term really means, we must examine more closely the nature of friction.

In a movement of any body friction must be overcome by work. There are three kinds of friction—solid, rolling and fluid. Lubrication is essentially the substitution of fluid friction for solid friction. The result is much like the discovery of early man that it was easier to float a log than to drag it.

Mechanism of Lubrication

How does a lubricant accomplish this transition? The explanation isn't a simple one, but the rudiments of it are as follows: No surface is smooth, no matter how carefully it has been machined or ground. There are always jagged teeth such as those shown in the exaggerated drawing below. When two of these surfaces are moved across each other, there is solid friction increased by interlocking of pits and ridges. Hence when these two jagged surfaces are separated by oil, fluid friction results.

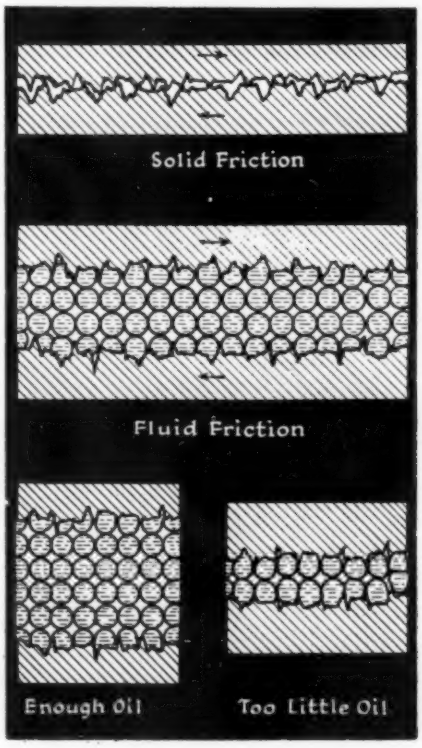
Suppose we consider an oil molecule as an ultra-small pliable sphere like a minute rubber ball. We can then conceive of the pits in our jagged surface being entirely filled by these spheres so that the body presents a

smooth surface. Then if we insert additional rows of oil molecules the two surfaces can roll over one another as though on ball bearings. (The foregoing though not entirely factual is the simplest explanation of the mechanism of lubrication. What actually happens is quite complex and is not thoroughly understood.)

At this point the question naturally arises "What peculiar property do lubricants possess that makes them act the way they do?" Some might say viscosity or oiliness, but the answer is more fundamental than that. It goes back to two properties of matter known as *cohesion* and *adhesion*.

All materials have a certain amount of each property, but most materials are predominantly one or the other. Steel is cohesive; oil is adhesive. Oil molecules would rather adhere to a molecule of steel than to each other. Thus when oil is dropped on a steel surface, it immediately spreads out in a thin film. Water dropped in a similar manner would remain a drop on the steel surface. It is more cohesive and not as good a lubricant. So a good lubricating oil must possess a maximum of adhesion and a minimum of cohesion.

Adhesion is by no means the only property an oil must possess. In addition, it must be able to withstand pressure and heat, to resist dilution and contamination, to flow at low temperatures, and to guard machine parts against corrosion and wear. Not an easy one is the job cut out for a lubricant, and oftentimes no single-base oil can satisfy all the requirements of a particular job. Thus it is the lubricant must often be tailor-made—blended from various mineral, and perhaps animal and vegetable oils—to achieve a desired result.



Why Do We Lubricate?

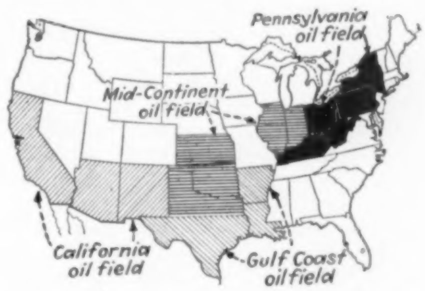
Now that we have outlined what lubrication is and how it performs its function, the answer to "Why do we lubricate?" seems rather self-evident. Obviously we lubricate to save power, to cut down on the work absorbed by friction. But there are other reasons, too. In most cases we lubricate to prevent wear. Sometimes we lubricate to carry away heat from some machine part or process vessel. (Too often this factor is overlooked). Sometimes, as in the steam engine, water condensation on the cylinder walls must be considered. Sometimes fine bits of metal must be swept from a bearing surface to prevent scoring. And sometimes the lubricant is a medium for transferring pressure from one part of a machine to another.

With this brief explanation of the whys and wherefores of lubrication, we are ready to discuss the properties of lubricants so that we may select a particular lubricant for a given job.

Part II—Properties of Lubricants

There are but two fundamental considerations in the selection of a lubricant: (1) the chemical and physical properties of the lubricant itself, and (2) the type of service required of it. These considerations are, of course, qualified by certain other factors such as the type of lubricants available, their cost, and plant facilities for lubrication already installed.

Properties of a lubricant may be determined from two things: (1) the source of the lubricant and (2) physical and chemical tests.



Principal oil-producing states of the U. S. A. are grouped according to fields

Source of Lubricants

Oils are of three kinds: mineral, animal and vegetable.

Mineral—Most important of all lubricants from the standpoint of volume is oil derived from petroleum. Crude petroleum flows from the earth at the rate of almost two billion barrels yearly, and apparently will continue to do so for a number of years to come (despite some opinions to the contrary). In the United States there are four important fields. The Pennsylvania field (N. Y., Pa., Ohio, W. Va., Ky.) produces *paraffine-base* crudes. The Mid-Continent field (Kan., Okla., N. Tex., Ill., Ind.) produces *mixed-base* crudes. Then there are two Western fields, Gulf Coastal (Ark., La., S. Tex.) and California (Calif., Ariz., N. Mex.). Both of these produce *asphalt-base* crudes.

All petroleum crudes are made up of paraffines, naphthenes and aromatics.

Animal—A number of animal oils are suitable for compounding with mineral oil for service in steam cylinders and elsewhere. Among them are tallow and lard oil, the former obtained by pressing beef or mutton tallow, the latter by pressing pig fat. Tallow oil is also used in greases to keep the mineral oil from separating out. Lard oil is used as a cutting oil (diluent), in some engine lubricants and in stainless oils.

There are many other animal oils including neatsfoot, sperm, whale and fish oils, but none of these is important for lubrication of process equipment. Exceptions are, of course, in the lubrication of fine instruments and in the leather industry.

Vegetable—First among the vegetable oils in lubricating value is castor oil. Pressed from the seeds of the castor plant, it has the highest viscosity and specific gravity of any *fixed* oil (oil which decomposes when distilled). Castor oil does not mix well with mineral oils unless accompanied by lard or rape oil. Rape oil is made by pressing imported rape seeds.

Other vegetable oils—cottonseed, olive, coconut, peanut, etc.—are used somewhat as cutting oils but not to any great extent in chemical industry.

Most fixed oils find their greatest use in compounding with mineral oils to lubricate heavy equipment where moisture is present. Because of their high adhesion and low cohesion, they increase the wetting power of mineral oils.

Lubricating Oils—According to degree of refinement and type of compounding there are various common lubricating oils. *Dark cylinder oils*, chiefly for lubricating steam engine valves and cylinders, are mineral-oil residues freed from their impurities and may be mixed with 3–10 per cent acidless tallow oil or degras. *Red oils* are fire-distilled, acid-treated oils, the base for medium- and heavy-viscosity

oils for general lubrication. Mixed with filtered cylinder oil, they produce very heavy-viscosity engine and machinery oils. *Pale oils* are fire-distilled and heavily acid-treated or filtered. With light to medium viscosity, they lubricate quick-running machinery and form a base for yellow greases. *Natural oils* are distilled, bleached and filtered, and form the base for most kinds of circulating oils, such as in self-oiling bearings, steam turbines, etc. *White oils* are acid-treated or filtered to remove color and used for transformer oils. It is hard to decolor paraffine-base crudes.

(The foregoing is correct in principle, representing conventional methods of refining. However, many improvements—such as solvent treating—have been made in recent years.)

Greases—For the most part greases are mineral oils dispersed in a soap base; however, some oils thickened with other materials also fall in this classification. The general procedure for their preparation is to saponify a fatty oil or acid with alkali, then add the mineral oil. General types of greases together with their characteristics are given in the table. There is, of course, some overlapping in this classification; so it should not be used too rigidly.

There are other types of greases, too—mixed-base greases (lime and soda), lead-base greases, barium-base greases, etc. Some of these are used for specialized purposes. Variations of those mentioned above include graphite grease, which contains as much as 20 per cent of graphite and gear grease made with heavier lube oils for heavier service. Axle greases are usually lime-base greases made with rosin oil.

Extreme Pressure—In recent years a new type of lubricant has become available, known as Extreme Pressure (or E. P.) lubricant. One authority has referred to this series as lubrication "alloys" because they are lubricants with chemicals added to give them unusual properties. Sulphur and chlorine are the "alloying" constituents (often called lubricant assistants) most frequently used. Some E. P. greases are of the lead-soap variety with sulphur added. There is a distinction between corrosive and non-corrosive E. P. lubricants, and both sulphur and chlorine lubricants can be made non-corrosive. Most non-corrosive, however, are of the lead-soap type. Outstanding property of all E. P. lubricants is that they continue to provide lubrication at pressures where the fluid film breaks down and ordinary lubricants fail. How this is accomplished will be described in Part III.

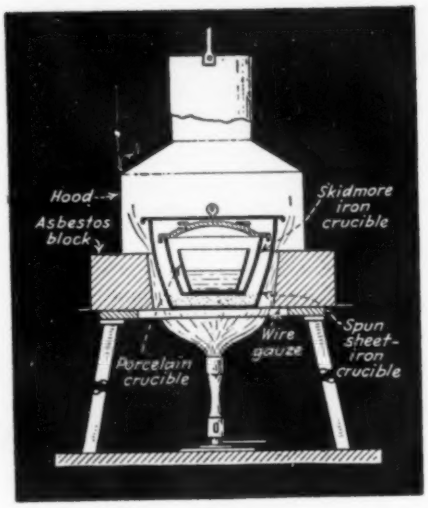
Others—Several solid materials are adaptable as lubricants for unique purposes. Some of them are: graphite, talc, soapstone, white lead, flowers of sulphur and mica. Most important of these is graphite which is resistant to acid and alkalis, to high and low temperatures, and to extreme pressures. Colloidal graphite, especially, is finding numerous new uses because of its ease of application, good wearing qualities, and tendency to avoid contamination.

Flowers of sulphur and amorphous carbon are of little value at elevated pressures. Powdered talc, soapstone and mica find their chief value in greases or thickened oils.

Thus we see that a lubricant may be any one of the above-named materials or some combination of them. If we know how a lubricant is made, we can predict certain properties for it, but to get the complete answer we must conduct tests.

Testing Lubricants

Oils are tested two ways: (1) for their physical characteristics, and (2) for their chemical composition. For



Carbon-forming tendencies of an oil, tested in apparatus like this, may indicate whether or not an oil is suitable for high temperature work

most tests, rigid specifications have been set up by the American Society for Testing Materials. (See 1939 Book of A.S.T.M. Standards, Part III). By far the most important property of any oil is its viscosity.

Viscosity—This property of an oil is a measure of its ability to withstand internal deformation. *Absolute viscosity*, the chemists' term, is the force in dynes required to shear a square centimeter of fluid one centimeter in one second. It is measured in *poises*, or more conveniently, in *centipoises*.

However, the engineer has a measure of viscosity that is much easier to determine. It is the time required for 60 cc. of the fluid to flow through a standard orifice under a standard head. Because the apparatus for making this test is known as the Saybolt Universal viscosimeter, the viscosity of a fluid is given in terms of *Saybolt Universal seconds* (there are also Engler, Barbey and Redwood units).

Temperature is a vital consideration in any determination of viscosity. Obviously, an oil would have a lower viscosity at high temperature than at low; so with either type of viscosity rating, the temperature must be included. Temperatures most frequently used on the Saybolt Universal viscosimeter are 100 and 210 deg. F.

In order to translate from Saybolt seconds to centipoises, it is necessary to determine a third property, *kinematic viscosity*, which is a ratio of the absolute viscosity to the specific gravity of a fluid. It is measured in *stokes*. Equating the kinematic viscosity determined from absolute viscosity to that determined empirically by Saybolt, we have this relation between the three viscosities:

$$K.V. = \frac{Z}{\rho} = 0.22\ t_s - \frac{180}{t_s}$$

Characteristics of General Types of Greases

Kind	Type	Saponified With	Upper Temp. Limit, deg. F.	Characteristics
Lime base	Cup	$Ca(OH)_2$	175*	Smooth, water insoluble, separates on boiling out water content, limited consistency loss on working.
	Axle	$Ca(OH)_2$ (contains rosin)	150	Smooth, sticky, water insoluble, separates on boiling out water content, great consistency loss on working.
Soda base	Fiber and sponge	NaOH	375	Fibrous, water resistant, does not separate at elevated temperatures, variable consistency loss on working.
	Medium and short fiber	NaOH	375	Semi-smooth, water resistant, does not separate at elevated temperature, variable consistency loss on working.
	smooth (block, brick)	NaOH	400	Smooth, hard, water resistant, does not separate at elevated temperatures.
Aluminum base	....	$Al(OH)_3$	240 (avg.)	Smooth gel-like or stringy, water resistant, becomes fluid at elevated temperatures, limited consistency loss on working.
Compounds	Residuum	No soap	......	Smooth, black, adhesive, excellent pressure and water resistance.

*As high as 200 deg. F. for special lime-base greases where such maximum temperature is intermittent.

where K. V. = kinematic viscosity, centistokes
Z = absolute viscosity, centipoises
ρ = specific gravity
t_s = Saybolt Universal seconds

Nomographs and tables have been made from this and similar relations to facilitate the conversion. (See "Lubricants and Lubrication" by J. I. Clower—McGraw-Hill.)

Viscosity Index—This quantity has become more important in recent years. First described by Dean and Davis in *Chem. & Met.*, Oct. 1929, pp. 618–9, it is an arbitrary value measured by the relation between the viscosity of a given oil and that of an average Pennsylvania and an average Coastal at 100 deg. F., all three having the same viscosity at 210 deg. F. A high V. I. oil does not undergo extreme changes in viscosity when heated or cooled and is generally desirable for most purposes.

Pour Point—Roughly, the temperature at which an oil no longer flows when it is being cooled, is called its pour point. It is important only that the pour point is below the lowest temperature which will be reached by the lubricated parts whether operating or not.

Demulsibility—This property of an oil is a measure of its ability to separate from water. It is measured by emulsifying oil with water or bubbling in steam and recording the time necessary for the oil to separate.

Carbon Residue—Oils subject to high temperatures while in use should have low carbon residue. This property is measured by heating the oil in the absence of air and weighing the carbon residue. The test is not altogether reliable, though, because poor correlation between laboratory tests and carbon residues formed in service has often been reported.

Flash Point—The lowest temperature at which an oil gives off vapors which will ignite when momentarily exposed to a flame is the flash point. It may be taken in an open or closed vessel. In any case it has little significance to the user of a lubricant. It is said to show evaporative tendencies, although again the correlation is not dependable.

Corrosion Test—A strip of polished copper is placed in the oil for a certain length of time (3 hr. at 212 deg. F. according to Bureau of Mines). If no pitting or discoloration is evident after washing with sulphur-free acetone, the oil is substantially noncorrosive. Moisture in oil often renders it corrosive to bearing surfaces; so it is important to eliminate sources where moisture may be collected.

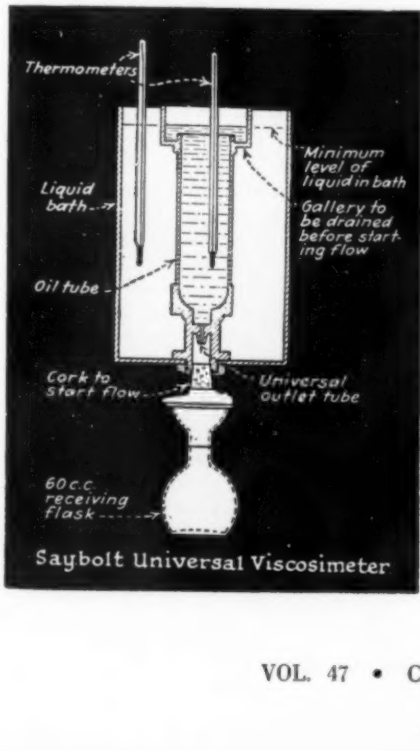
Neutralization Number—Acidity of an oil is determined by the weight in milligrams of KOH required to neutralize one gram of oil. In general it is a measure of the degree of refinement of new oils and the deterioration of used oils.

Many other measurements are usually made on lubricating oils, such as precipitation number, an indication of asphalt; water test; wick-feed test, a measure of capillarity; sulphur test; saponification number, to determine amount of compounding with animal and vegetable oils; etc., etc.

Grease Tests—There are not as many tests for grease and they are not as well standardized as in the case of oil. Consistency is one of the more important properties, although tests for it are not altogether satisfactory. It is tested usually by penetration—the dropping of a standard cone into a standard container of grease at 77 deg. F. Depth of penetration in hundredths of a centimeter is observed.

Other tests are for odor, texture, elasticity, melting and dropping points, etc.

In addition to all these tests there are, of course, the "practical" tests where a sample of the lubricant is placed on some type of friction machine and its performance is carefully measured. Again there is difficulty in correlating test data with operating data. However, this type of test does provide a measure of one property of oil which cannot be determined otherwise—"oiliness." Oiliness has been defined in various ways, and it apparently embodies all the *unknown* properties of an oil. In other words, if you consider two different oils, equal in viscosity and equal in other known properties, the difference in their performance is accounted for by difference in oiliness.



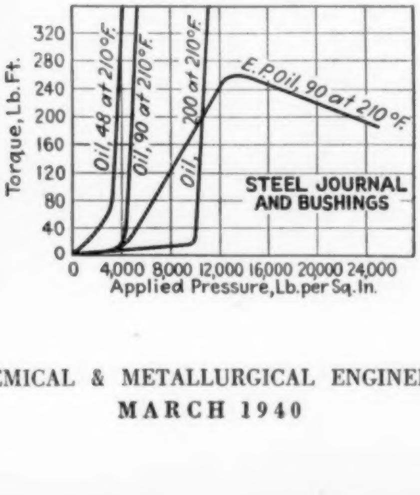
Saybolt Universal Viscosimeter

Part III—Application of a Lubricant

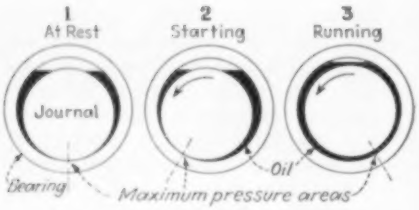
When a journal and its bearing are properly lubricated there are theoretically three films of oil separating them. There is one so-called *boundary* film adhering to each of the metal surfaces (one molecule thick) and there is the fluid film in between. This is said to constitute *fluid-film* lubrication.

Now if at the operating pressure the oil in the fluid film is squeezed out of the bearing, a better lubricant should be used. The bearing is still being lubricated by the boundary film, however, and that's where the "oiliness" of a lubricant comes in. Some oils, with more oiliness than others, can maintain lubrication in this *thin-film* region longer than others. But this film eventually breaks down. Even a heavy oil with an S. U. viscosity of 200 seconds at 210 deg. F. cannot withstand pressures in excess of 11–12,000 lb. per. sq. in. Then there is actually metal-to-metal contact and wear takes place.

An extreme pressure oil acts just the same as another oil of the same viscosity in the range of fluid-film lubrication. But at higher pressures where the fluid film breaks down, the *lubricant assistants* in the E.P. oil come into play



The solution to these high-pressure problems is extreme pressure lubrication. These lubricants too are squeezed out of the bearing, but the boundary film remaining is more durable. Perhaps E.P. lubricants have more oiliness. At any rate some authorities account for this tenacity of the thin film by the theory that there is actually a chemical bond between the lubricant and the metal. With ordinary oils, this bond is not strong, but with E.P. lubricants, because of their chemical constituents, it is extremely strong. The accompanying plot of actual data lends support to the theory. The important thing to consider about E.P. lubricants is that their *extreme pressure properties are independent of viscosity*. Strange, but true that a low-viscosity E.P. lubri-



cant may have the same extreme pressure properties as one of high viscosity.

Therefore, make sure all bearings have sufficient lubricant to maintain fluid-film lubrication unless using E.P. lubricants (seldom, if ever, used in chemical industry). If the oil won't stay in the bearing, use a heavier oil.

In starting a journal in a bearing, there is a special problem. Usually metal-to-metal contact exists when the journal is at rest. When it starts to rotate, it climbs part way up the wall of the bearing allowing a wedge of oil to form under the journal. Then as the journal picks up speed it acts as a centrifugal pump forcing oil between it and the bearing until the film is established. In the running position, then, there is an oil film all around and the point of maximum pressure is a little to the right of the lower bearing center-line as shown in the drawing. Because of this action, journals should usually be started under reduced load.

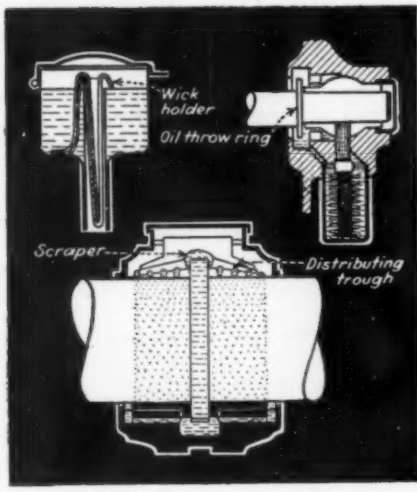
Methods of Lubricating

There are any number of lubricating devices, and space limitations forbid the description of all of them in this report. Therefore we shall endeavor to cover only the more important principles of lubricators.

Hand Oiling—The old-time oil can, though handy for some purposes, is wasteful and undependable. It is still used for some purposes but not as an important method of plant lubrication. One authority states that the cost of hand oiling will run up to $3 for each $1 worth of lubricant purchased.

Drop Feed—There are five types of drop-feed lubricators which have extensive application on individual solid and anti-friction bearings, chains, gears, etc. Principal general characteristics of the group are that they are not always dependable, require much care and attention. Yet they are convenient to install and replace and low in cost. Devices in this classification are: sight feed drop oilers, wick oilers, bottle oilers, special types such as rod cup lubricators for reciprocating arms or check-valve oilers, and mechanical lubricators.

Essential features of the mechanical lubricator are: an oil reservoir, one or a number of mechanically operated pumps (usually of plunger type), and strainers at the oil entry to the pump.



Top, left to right—Wick-feed oil cup and bottom wick-feed oiler. Bottom—collar-oiled bearing with distributing trough and scraper

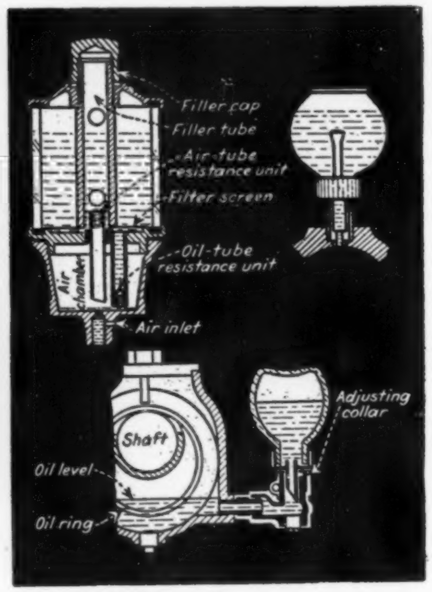
The plungers are usually of small diameter and relatively long stroke. They are usually cam driven by ratchet and pawl operated by a lever, continuous reduction gears, multi-speed pulley or wobble plate.

Important points to watch for in efficient operation of mechanical lubricators are: (1) check valves should be fitted at all discharge ends to keep oil in the line when not running; (2) oil feeds should be independent of one another; (3) there should be no variation in oil delivery caused by variations in oil viscosity or temperature, oil level, or back pressure; (4) oil feeds should be adjustable from the outside; (5) the unit must be free from the possibility of air lock; (6) an efficient strainer is desired—not too shallow, preferably with solid bottom and not too fine a mesh; (7) there must, of course, be little wear on the moving parts.

Waste and Pad—Essentially this consists of some form of oil-soaked waste or felt pads. The pad is in contact with the journal and also with a reservoir of oil, lubricating by capillarity.

Bath Oiling—With this lubrication system, the bearings or other lubricated parts are immersed in oil at all times. This type of lubrication is widely used in chemical industry because of the small amount of maintenance required. Obviously, the oil level must be kept within certain limits and the reservoir cleaned periodically. A high grade of oil is required to insure long life.

Ring, Chain and Collar Oiling—Here again, we have devices that are widely used in chemical industry, especially on solid bearings. The ring, chain or collar dips into an oil reservoir below the journal and carries oil up to the journal. The type of oiler used depends on the speed of rotation,



Top—In both the temperature-regulated oil cup (left) and the bottle oiler (right) heat is conducted from the bearing to the air space above the oil thus exerting pressure to force more oil to flow

with ring oilers for higher speeds, collar oilers for lower speeds.

In the ring oiler type, the ring is usually twice the diameter of the shaft. The best oil level is usually one-half the diameter of the shaft below the shaft. One ring will take care of bearings up to 6 or 8 in. in length.

Splash Lubrication—For groups of bearings, splash lubrication is quite common. It requires an inclosed crankcase with oil trays into which connecting rods dip. Oil reaches the lubricated parts by splashing, by being conducted through pipes or drilled passages and by mist which carries to remote parts.

Obviously the amount of lubrication supplied by the system is controlled by the oil level. If the level is too low, lubrication is insufficient; if too high, it is wasteful. Because of the extreme agitation necessary by this method, oil must be of good stability. Moreover it must endure relatively long periods of service.

Circulation Oiling—Circulation systems may be of two types—gravity or pressure force-feed. In the gravity system, oil is fed from an overhead supply tank and distributed by piping. The oil is picked up after leaving the bearings by a pump and returned to the overhead supply. Top and bottom tanks are required. Sight feeds, regulators, settlers and filters may, of course, be used with this system.

In the pressure force-feed system, a mechanical lubricator or pump replaces the overhead gravity tank. This is a most efficient system, positive in oil delivery and used extensively for lubrication of bearings on turbines

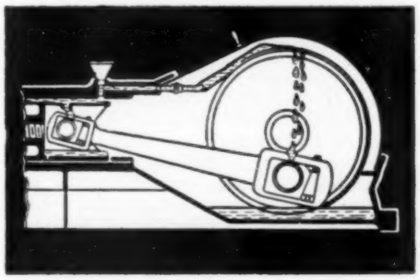
and steam, diesel, gas and gasoline engines. It readily permits reconditioning and cooling of the oil during use.

There are other centralized systems of the "one-shot" variety where oil is supplied periodically by a mechanically operated pump or hand plunger.

Grease Lubrication — The ordinary grease cup and pressure gun are quite familiar and need no explanation. The automatic-type grease cup has a reservoir that is filled from a grease gun through a fitting, the reservoir containing a spring-actuated plunger which controls the amount of lubricant supplied.

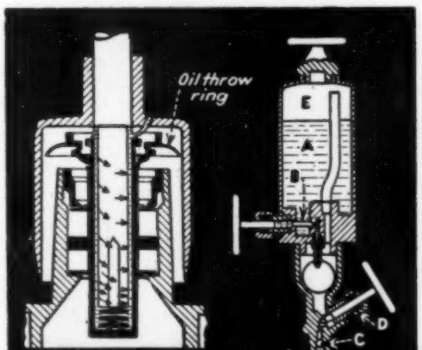
Central grease systems operate much the same as centralized one-shot oiling systems. A pump or plunger forces the grease from a reservoir into the grease line and out through various metering valve outlets. Some systems of this type will handle either oil or grease.

Lantern Glands — Oftentimes in chemical industry both oil and grease are introduced through a lantern gland, which is a spacer placed in a stuffing box to lubricate the packing. Lantern glands are also used to seal the packing against leakage. In this case, a sealing liquid is introduced under pressure.



Above—Splash circulating system.

Below—Bath oiling on a vertical shaft at left and a sight-feed lubricator at right. Oil container *a* is drained through feed-regulating valve *b*, main shut-off valve *d* and check valve *c*. Pipe *e* admits air over the oil, allowing the latter to run out by gravity



A dangerous chemical can sometimes be handled this way. For instance, a pump handling hot sodium may be lubricated by an aluminum stearate grease of about 290 Penetrometer number at 77 deg. F., supplied to a lantern gland by a compression cup or pressure gun.

According to the Technical Department of Standard Oil Co. (Ind.) the ideal lubricating system or device should:

1. Form and maintain a satisfactory lubricating film under all conditions of operation.
2. Be economical in operation — feed only enough lubricant to maintain a film while the equipment is in motion — not feed while the equipment is at rest.
3. Be automatic — require very little attention.
4. Protect the lubricant from contamination, dust, dirt, water, etc.
5. Carry away heat from bearings by a continuous flow of the lubricant.
6. Be convenient to service with lubricant.
7. Be rugged enough to withstand normal abuse and not readily break or become inoperative.
8. Moreover, installation costs should not be too high in proportion to the benefits to be derived.

Storing and Handling of Lubricants

For some reason or other, an oil room seems to fairly breed contamination—probably because many employees feel that oil is dirty anyway and it makes little difference if the room in which it is kept is likewise dirty. As a result, in far too many plants the oil room is a "catch-all" where filth is allowed to collect. Actually, if any part of the plant needs "good housekeeping," the oil room is that part. Lubricants must be free from contamination if they are to function properly. The suggestions that follow are passed on from recommendations of leading oil companies.

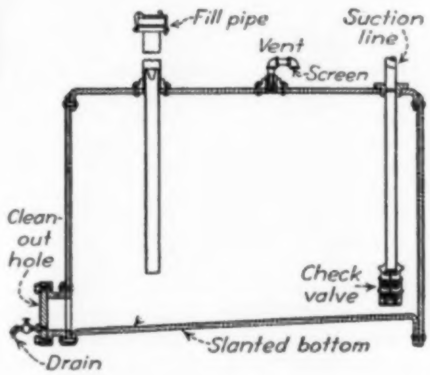
Store oil in clean containers, cleaned with kerosene since the last batch of oil was in them. (Be sure kerosene is all removed, however.) Larger tanks can be made of sheet iron or sheet steel. Don't use galvanized iron as zinc is likely to react with the oil. Provide for heating oil tanks if they are not in a heated room. Do not heat oil above 70 to 100 deg. F.

Barrels should be stored on their sides until ready for use, preferably in a heated room. If they must stand on end, tilt them with the bung on the high side.

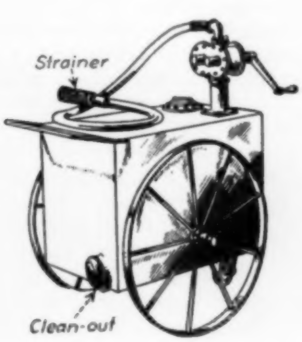
Oily rags and waste invite fire. Keep them in a metal container near a fire extinguisher.

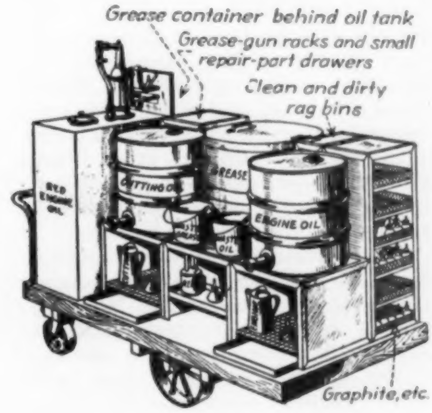
Keep stocks of oil small and use the oldest oil first. Be careful not to mix various grades. All containers should have vents to take care of breathing, away from dirt and moisture-laden air. Even so, oil will eventually collect some water and dirt or rust. Therefore provide storage tanks with sloping bottoms and drain plugs.

Use a wheeled tank truck for transporting oil from central storage to points of dispensation unless oil volume is large enough to warrant pipe lines from storage. If possible, provide oil storage near the machines for the operators' convenience. For general all-around lubrication the plant oiler should be equipped with a truck similar to that illustrated herewith.



Left—A good storage tank design, allowing for easy removal of contaminants. Below—Portable oil and grease truck suitable for use of plant oiler. Center—Type of portable tank with 2-way pump for pumping from barrel, then into machine or dispensing tank





Part IV—Chemical Factors in Lubrication

As has already been explained, besides the ordinary run-of-the-mill lubrication problems found in all industry, chemical plants have special problems because of the nature of the materials handled. There is no cure-all for these problems. Each and every one of them must be treated individually. For that reason, we cannot solve your problem here. We can merely point out the symptoms by which you may *recognize* such a problem and describe some of the factors that may be involved in its solution.

There are two ways of solving most of these specialized problems: (1) by using special lubricants prepared specifically for the situation at hand, and (2) by making use of special equipment designed to prevent ordinary lubricants from interference.

Use of Special Lubricants

In practically all chemical plants some kind of corrosive or solvent chemical fluid must be transported. For this purpose pipes, pumps, compressors, fans, blowers and valves are used. All these types of equipment often require specialized lubrication. Plug valves, especially, because of their wide use in chemical industry require special lubricants. Here the job is not merely one of reducing friction, but the lubricant must protect the valve against corrosion, stop leakage and even aid in opening the valve by exercising hydraulic pressure between seat and plug. Elsewhere in this issue (see p. 164) this type of lubricating problem is described more completely. Suffice it to say here that the lubricant may include such materials as mineral, animal, and/or vegetable oils, fats and waxes, soap, glycerine, synthetic resins, graphite, talc, soapstone, mica and others.

To state a few specific cases where specialized lubricants are used, there is the classical example of the sulphuric acid plant where equipment is lubricated with sulphuric acid—although oftentimes other parts of the same plant (in the presence of SO_2 fumes) may be lubricated with ordinary cylinder stock. Compressors for handling oxygen are usually lubricated with soap and water, although mineral oil is used successfully in some instances. On the other hand, air compressors generally use oil—an oil with low carbon residue and high temperature resistance, of course.

In the handling of viscose rayon, especially in the metering pumps, viscose is the best lubricant. The reason is to avoid contamination of product. Handling hydrogen gas requires special technique, soap and water generally being used for lubrication. Likewise equipment for handling oxides of nitrogen is generally soap and water lubricated although mineral oil lubrication has been successfully used in at least one installation. Solvents are quite troublesome as it is necessary to lubricate with a material that is insoluble, yet has lubricating properties. The petroleum industry has many problems in this respect varying all the way from lube oil pumps which are self lubricating to gasoline pumps which are often lubricated with modified castor oils.

These few examples illustrate at least three of the basic problems—explosibility, contamination of product and resistance to corrosion. They serve to point toward a proper approach to any chemical plant lubricating problem. Obviously when a chemical engineer tackles such a problem, he should consider these things:

1. Properties of chemicals being handled.
2. Reactions likely to occur between chemicals and conventional lubricants.
3. Possibility and effect of product contamination.
4. Operating conditions—temperature, pressure, speed.
5. Operating atmosphere — dry, moist, explosive, corrosive.

To lubricate stuffing boxes on blowers handling SO_2, SO_3 or sulphuric acid fumes, for instance, use a technical white oil. Because this lubricant has received three separate treatments with H_2SO_4 to remove all unsaturated hydrocarbons, it follows that there is nothing left for the acid to attack.

Temperature is quite often the most important consideration. When the temperature gets up around 500 deg. F., it becomes necessary to consider lubricants other than petroleum products. While there are oils that will withstand that temperature and more, there are few that can stand it for any length of time. (If the lubricant is circulated at a high rate, higher temperatures may be used). Most important of the high temperature lubricants is graphite, either mixed with kerosene or in the colloidal state. In one case a conveyor in a ceramic plant moved in jerks rather than smoothly. Conventional lubricants were barred by both high temperature and product contamination considerations. Colloidal graphite suspended in kerosene and carbon tetrachloride solved the problem. It was merely sprayed on by an automatic device; the solvents evaporated and a graphitic film performed the lubrication.

Cost is seldom a big factor in determining the proper lubricant for a chemical plant use. Chemical plant engineers don't expect nearly so much of their lubricants. They expect their equipment to have a high rate of depreciation, to wear out from corrosion before it wears out from lack of lubrication. That attitude will perhaps change as the industry swings more and more to corrosion- resistant materials of construction.

Sealing Devices

The other important means of obtaining proper lubrication in the presence of chemicals is to seal off the lubricant from the chemical by some kind of a leak-proof packing, sealed stuffing box or other type of patented sealing device. There are any number of these devices on the market and we shall not endeavor to cover them here.

As pointed out above, the chemical engineer may often analyze his problem well and still be unable to solve it. That's when he should team up with the lubrication engineer. But one word of caution. If you want a satisfactory solution, give your lubrication engineer all the facts. Many are the times a lubrication problem was never properly solved because a chemical man knowingly, or unknowingly, presented only half the picture.

Bibliography

Best among the recent books on this subject is "Lubricants and Lubrication" (McGraw-Hill) by James I. Clower. (See review on p. 200). Other fairly recent books include "Theory of Lubrication" (John Wiley) by M. D. Hersey, and "The Principles & Practices of Lubrication" (published in England, distributed by Chemical Pub. Co.), by A. W. Nash and A. R. Bowen.

Some of the technical societies have published bulletins on lubrication and papers which were presented at their meetings. Among them are A.S.M.E., A.P.I. and A.S.T.M. The latter has an excellent booklet just off the press called "Evaluation of Petroleum Products."

Practically all the nationally known lubricant manufacturers have published elaborate booklets, periodicals and technical bulletins on the subject. "Lubrication" of the Texas Co., "Engineering Bulletins" of Standard Oil Co. (Ind.), "Oilways" of Standard Oil Co. (N.J.), "Research Illustrated" of E. F. Houghton & Co. and "Panorama of Lubrication" of Shell Petroleum Corp. have been especially helpful in preparing this section.

Power has published any number of articles on lubrication including such information as a fairly complete list of lubricant manufacturers (June, 1937). Some of the illustrations for this section were taken from a similar section in *Power* prepared for the power plant engineer.

Two excellent articles of very practical nature by Lawrence G. Benton and William Staniar appeared in the June and August numbers of *Chem. & Met.*, 1936.

Reprints of this report are available for 25 cents each from the editorial offices of* Chem. & Met., *330 West 42d St., New York, N. Y.

Machinery, Materials and Products

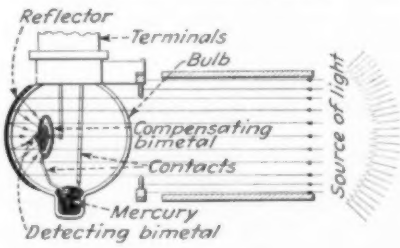
Centrifugal Dischargers

SEVERAL improved types of dischargers for suspended centrifugals have recently been announced by the American Tool & Machine Co., Hyde Park, Boston, Mass. They are claimed to be particularly safe for both men and machines and to be the easiest and speediest to operate. The "shoe-on-curb" type has a new washer arrangement which permits precise adjustment of the plow. The "hanging-in" type now employs a split handle which acts as a double safety lock when the plow is raised. No annular motion of plunger and shoe is possible until the operator lifts the handle and simultaneously raises the plunger.

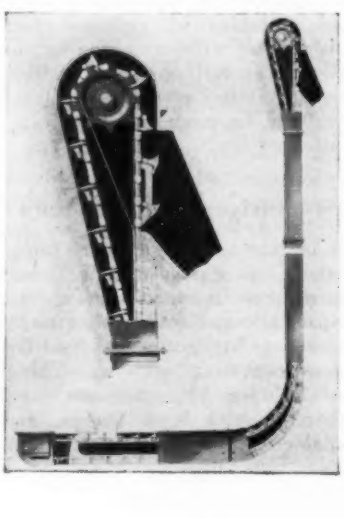
Flame Controller

TO PROVIDE protection against flame or power failure in oil- and powdered-coal-fired furnaces, the Mercoid Corp., 4201 Belmont Ave., Chicago, Ill., has introduced a new flame-control system, known as the "Visaflame". The new device is operated by light from the burner flame rather than by the heat of combustion and consists of a glass bulb mounted on a stainless steel focalizing tube and installed so as to view the flame. Light from the flame is focused by means of a concave reflector on a small bimetallic coil. Absorption of the light produces a small amount of heat causing the bimetal to move a contact into a pool of mercury. In the event of flame failure the bimetal withdraws the contact and opens the circuit. Ambient temperature changes are compensated for by a second bimetal opposed to the coil on which the light is focused.

Visaflame furnace control



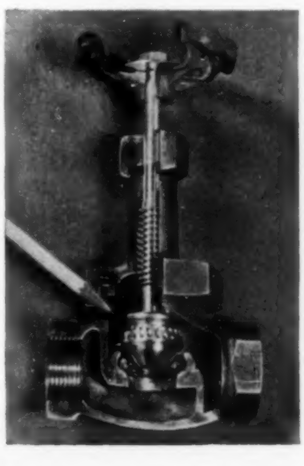
Mass-Flo conveyor



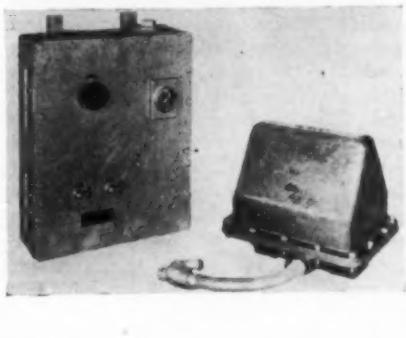
Mass-Flow Conveyor

INTENDED for low-cost handling of all kinds of granular materials such as chemicals, coal and soap chips, is the new "Mass-Flo" elevator-conveyor recently announced by the Jeffrey Mfg. Co., Columbus, Ohio. This conveyor consists of a steel casing through which solid pivoted flights spaced at intervals on a single strand of chain move the material horizontally or vertically in a solid mass or with partial load, as desired. A simple type of tripper, as shown in the accompanying cutaway view, is employed to discharge the load. Since each flight is capable of carrying either a full or partial load, the device can be emptied after the feed stops. This conveyor is said to produce little agitation and thus practically to eliminate breakage and degradation. Low initial cost, self-feeding and self-cleaning are other features.

Cutaway Ostlind valve



Explosion-proof vibrator and controller

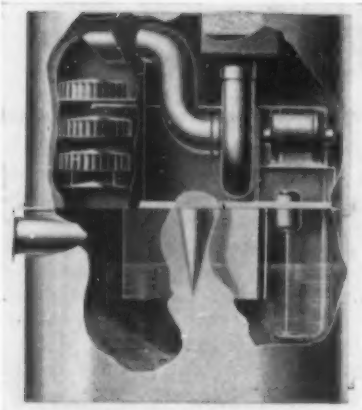


Spinning-Disk Valve

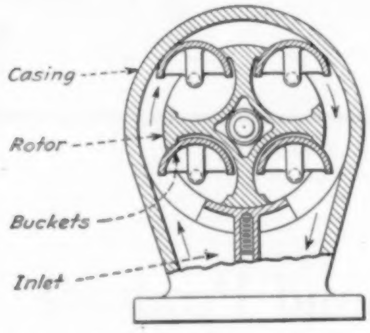
WHAT IS SAID to be a new principle in valve construction is employed in the Ostlind valve manufactured by Ostlind Valve, Inc., Portland, Ore. The innovation is the use of a spinning disk which rotates up to 2,000 r.p.m. for a moment preceding closing. The disk does not spin, however, when the valve is cracked or while throttling. A reversing chamber is used to direct steam flow through turbine blades cut in the disk just before the disk reaches its seat. These are shielded from the steam flow when the valve is opened. The spinning disk is claimed to throw off scale and other foreign particles and, owing to its momentum, to polish the line of closure at each closing. Two seats, one for closing and one for cracking and throttling, are used. These valves are built in sizes from ½ in. up.

Explosion-Proof Vibrators

A RECENT addition to the line of vibrating equipment made by the Syntron Co., 610 Lexington Ave., Homer City, Pa., is an explosion-proof model for use in plants where atmospheres contain flammable or explosive vapors. The vibrator, a heavy pulsating electro-magnet, is fully encased in a thick steel casing equipped with an armored cable lead and closed with ground joints. The remote electric control panel which contains a rectifier, operating switches and a rheostat for controlling the vibrator power, is also encased, a cast iron case with ground joints and approved explosion-proof fittings being used. Such vibrators are

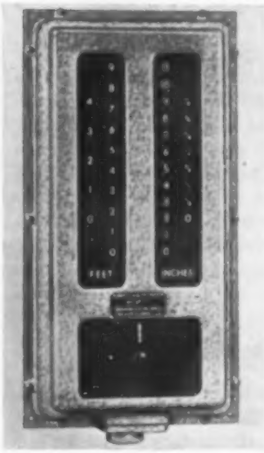


Cutaway view of midget dust collector

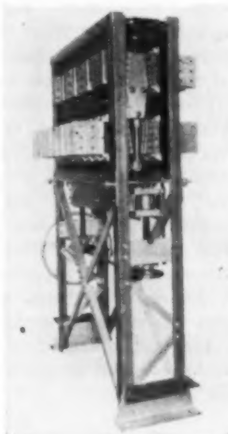


Schematic cross-section of meter

Below—Univibe vibrating screen



Indicator of remote tank gage



Electric furnace switch

used for prevention of arching and hanging up of material in bins, hoppers and chutes.

Midget Dust Collector

RECENT DEVELOPMENTS of the Claude B. Schneible Co., 3951 West Lawrence Ave., Chicago, Ill., include a new portable type midget dust collector and a new entrainment separator. The dust collector, which is illustrated herewith, employs the same principle as this company's standard Multi-Wash dust collectors, but is made only in six small sizes ranging from 300 to 1,500 c.f.m. and is a complete self-contained wet dust recovery system. As such, the unit is intended primarily for collecting dust and fumes arising from isolated operations not suitable for connection to a central dust collecting system. The fouled air is drawn into a miniature scrubbing tower where it impinges on numerous curved wet vanes arranged in several tiers. The air then passes through an entrainment separator, fan, diffuser and sound deadener. The liquid is settled in a sludge dewatering compartment and is recirculated through the Multi-Wash section. Motors are sealed against dust and moisture.

The second new development mentioned is a separator for air-borne entrainment which is identical in principle with the topmost stage of the collector shown in the illustration. Air or gas enters the housing of the unit tangentially and rotates through the multiple vanes, then leaving the separator.

Remote Level Gage

FOR USE in the petroleum industry, particularly, and wherever large quantities of liquids are stored in tanks, the Guardian Electric Mfg. Co., 1621 West Walnut St., Chicago, Ill., has developed a remote-reading liquid level gage which continuously indicates the level in the tank to the nearest 1/8 in., or even closer, if desired. The device consists of two parts, an oil-sealed tank unit and an indicator panel (see illustration) which is mounted at the desired point remote from the tank. A guided float supported on a perforated tape drives the oil-sealed registering mechanism. The latter is a commutating device which permits direct transmission of almost 5,000 different readings between control mechanism and indicator panel with only 39 wires needed in the main cable for the first tank, plus one wire for each additional tank. The indicator panel may be connected to any number of tanks up to 24 with standard equipment, or more if desired. When any tank is switched to the panel, feet of liquid depth appear in red numerals, inches and fractions in green. Tanks up to 50 ft. in height may be gaged.

Rotary Displacement Meter

DESIGNED primarily for accurate and dependable pipe-line measurment, a new meter known as the Rotocycle has been introduced by Pittsburgh-Equitable Meter Co., Pittsburgh, Pa. The new meter, which is of the positive displacement type, has no reciprocating parts, no pockets and offers no appreciable resistance to the liquid flow, according to the manufacturer. The meter consists of an elevated cylindrical housing, connected to inlet and outlet ports. The measuring element is a cylinder carrying four half-moon-shaped buckets on its periphery which are geared together so that as the rotor turns, these buckets change in position continuously with respect to the rotor and side walls of the meter, but remain constantly perpendicular to the meter connections. Their motion is identical to that of a Ferris wheel carrying four cars. Since the buckets move in a relation of close clearance to the casing, they act as seals and the rotation of the rotor is directly proportional to the fluid which has passed. This is recorded on an integrator.

Miniature Vibrating Screen

A LIGHT-WEIGHT vibratory riddle or screen, weighing but 39 lb. and operating from any light circuit at a cost of about 1/10 cent per hour, has been put on the market under the name of "Univibe" by the Universal Vibrating Screen Co., Racine, Wis. The machine may be held in the hands, operated on a small stand which is adjustable for operating angle, or suspended aerially by means of studs provided for the purpose. Freedom from blinding, a powerful separating action and easy changing of the low-priced screen panels are features claimed for the new riddle.

Electric Furnace Switch

TO MEET the demand for high-ampere switches for use with electric furnace transformers, a unique design has been developed by the Delta-Star Electric Co., 2400 Block, Fulton St., Chicago, Ill. This design is shown in an accompanying view. Double-throw, it permits easy and rapid switching of eight-coil furnace transformers without changing heavy cables. The series-parallel interconnections are factory-assembled so that the switch can be connected directly to the transformer leads.

New Refrigeration Machines

A RECENT ANNOUNCEMENT from the Carrier Corp., Syracuse, N. Y., describes improvements recently effected in this company's centrifugal refrigerating machines for large-scale air conditioning and refrigerating systems. This line now includes 12 compressor sizes, 9 evaporators and 9 condensers, making available 67 combinations to meet all requirements. Increased efficiencies have

been achieved by improvements in these various parts and horsepower has been reduced by 10 to 15 per cent for all sizes of machine, according to the manufacturer. Operating sound level has been reduced and the refrigerant pump has been eliminated. A new special extruded, extended-surface tube is used in the evaporator and condenser, reducing the lineal feet of tube required for a given capacity by 50 per cent or more. Thus evaporator and condenser size are greatly reduced. Tubes may be removed and replaced without disturbing the tube bundle. Carrene No. 2 is the refrigerant employed, claimed to be non-toic, non-explosive and non-flammable.

Flocculating Mixer

A RECENT DEVELOPMENT of the Chain Belt Co., Milwaukee, Wis., is the use of the Langelier process of multi-stage flocculation in design of equipment for mixing basins for water treatment plants. The Rex Slo-Mixer progressively decreases either the paddle speed or paddle area, or both. Flow is at right angles to the motion of the paddles. Baffles are said to eliminate short-circuiting and assure positive mixing. A variable speed drive unit is usually provided to permit changes corresponding to flow rate or liquid analysis.

Novel Steel Valve

A SO-CALLED "No Bonnet-Joint" valve, designed to end leakage through the gasket joint between the valve body and the bonnet at elevated temperatures and pressures, has been announced by the Hancock Valve Div. of Manning, Maxwell & Moore, Inc., Bridgeport, Conn. The new valve is made for pressures up to 2,500 lb. at 1,000 deg. F. It is stated to weigh less than one-quarter as much as a conventional bolted-bonnet valve of the same size and pressure rating. When welded into the line, the only joint is that of the stuffing box for the stem. Easy disassembly of the valve in the line for regrinding is claimed. The valve employs a stellite seat welded into the body and a heavily stellited valve disk. Sizes for ½, ¾ and 1 in. pipe are available.

Streamlined Pump

COMBINATION of a fully inclosed, self-protected electric motor with a centrifugal pump in a single compact frame has been announced by the Smith Meter Co., 5743 East Leneve St., Los Angeles, Calif. This new pump, known as the Smithway centrifugal, has several novel features. The pump frame is so constructed that water or other liquid being handled is passed around the thin tubular shell of the motor, providing definite and continuous cooling. The motor used is claimed to have the smallest size-to-power and highest power-to-weight ratio of any motor operating on standard cycle 3-phase current. This motor is a Sawyer Hi-Power tubular type, available in sizes from 1/2 to 10 hp. The pump is made in capacities ranging from 20 to 200 g.p.m., for heads up to 250 ft. and for operating temperatures up to 200 deg. F.

Improved Mixer Clamp

MIXING EQUIPMENT CO., Rochester, N. Y., has announced a new hand clamp which is now standard on all "Lightnin" mixers, at no increase in price on portable models 1/8 hp. and larger. The mixer may be locked in position for any selected mixing action with a simple turn of the handwheel. The chief feature of the new clamp is a double bronze wedge which is said to tighten the unit with great firmness and to preserve this tightness. Corrosion resisting construction is claimed to give permanent protection against "freezing."

Equipment Briefs

E. D. BULLARD CO., 275 Eighth St., San Francisco, Calif., announces that the U. S. Bureau of Mines has granted approval to the company's Simplex hose mask for protection against high concentrations of fumes, or against oxygen deficiencies, in cases where the maximum length of hose does not exceed 75 ft. This mask requires no blower.

A COMBINATION crusher and feeder said to introduce a new type of crushing action has been announced by the Prater Pulverizer Co., 1801 South 55th St., Chicago, Ill. As a feeder, the new machine is claimed to give positive, uniform feeding control, with crushing of lumps. Crushing action is based on a new design of crushing rolls employing a projecting stud of metal ahead of each cutting tooth on the rolls. Two rolls are used, working against a fully adjustable shear bar. Rolls are mounted in outboard bearings of anti-friction type sealed against dust and dirt. A shear pin is provided for protection of the machinery.

WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburgh, Pa., has announced a new line of speed increasers for operating centrifugal pumps, high speed blowers and compressors. Standard gear ratios vary from 2 to 1 to 12 to 1 and units are available in ratings from 1 hp. per thousand r.p.m. of the high speed shaft to more than 1,800 hp. per thousand r.p.m. Self-contained oil circulating systems are used. Average mechanical efficiency is claimed to be better than 96 per cent.

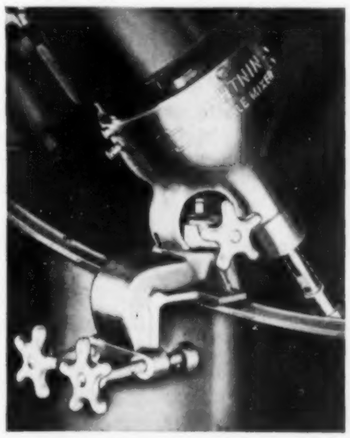
A NEW UNIT known as the Granular Moisture Register has been announced by the Moisture Register Co., 1029 North Sycamore St., Los Angeles, Calif. This self-contained electrical instrument measures resistance of granular materials in terms of moisture content. Material to be tested is placed in a cup and subjected to controlled pressure. An unskilled operator can complete a test in less than one minute, according to the manufacturer.

A NEW LIQUID CONDITIONER for the trapping of oil or grease or for the continuous separation of floatable solids

Typical arrangement of Rex Slo-Mixers

"No-Bonnet-Joint" valve

Improved "Lightnin" hand clamp



Streamlined centrifugal pump

from a liquid, or the separation of liquids of different specific gravities, has been announced by Gale Products Co., 50 West St., New York, N. Y. When the mixture enters the conditioner through the inlet pipe, the current is directed by a guide baffle downward and outward to increase the separating impulse. The current is then deflected by another baffle so as to aid the lighter component in rising to the surface. Continuous automatic removal of the lighter substance takes place through a gravity flow-off.

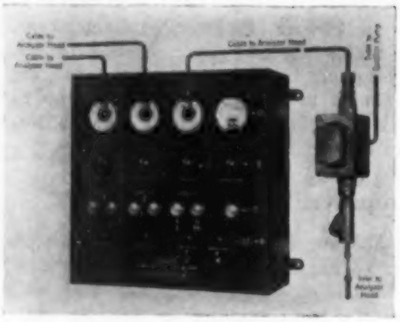
D. W. HAERING & Co., 2308 South Winchester Ave., Chicago, Ill., announces national distribution of the Nelson chemical proportioning pump made by Nelson Chemical Pumps, Casper, Wyo. This pump, developed for internal boiler treatment and general proportioning work, consists of a small power cylinder and pumping cylinder, containing a piston mutual to the two cylinders. Power impulses from either the power or fluid cylinder of the main pump cause the operation of the proportioning pump, reciprocating it in synchronism with the main pump. A simple means of stroke adjustment permits varying the volume of chemical pumped.

A NEW three-button control station recently placed on the market by the Allen-Bradley Co., 1311 South First St., Milwaukee, Wis., is available with various button markings such as forward-reverse-stop. A molded plastic cover, a die-cast box, with a conduit opening at one end and double-break silver alloy contacts in individual chambers are features.

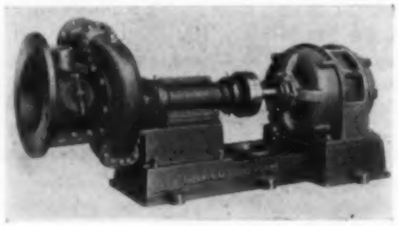
ROLLER CONVEYOR bearings lubricated for life and permanently protected against dirt by a dual seal are a new development of the New Departure Division of General Motors Corp., Bristol, Conn. A unique shape of inner ring is used to mate with the end of the stub shaft of the roller, assuring self-aligning action without the possibility of the ring turning on the shaft.

Proportioning Oil Burner

DESIGNED for either manual or automatic operation, a new proportioning oil burner said to burn any grade of oil has been announced by the Hauck Mfg. Co., 124 Tenth St., Brooklyn, N. Y. It is claimed that the new burner automatically and accurately proportions all primary and secondary atomizing air to the oil flowing through the burner, in the entire range from minimum to maximum capacity. The moving of a single lever automatically controls the oil and air supply, simultaneously adjusting both primary and secondary air orifices in the burner. Maintenance of desired furnace atmospheres consistently between 13 and 15 per cent CO_2 over the full range of burner rating is claimed. Five sizes ranging from 1½ to 6 in. air inlet are available.



Continuous combustible gas indicator



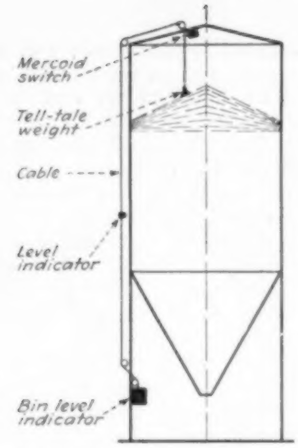
Pump for high-consistency stock

Bin Level Indicator

A SIMPLE DEVICE for automatically making intermittent measurements of the height of solid materials in bins and hoppers has recently been announced by the Dracco Corp., 4071 East 116th St., Cleveland, Ohio. The device consists of a cable with a weight suspended from it inside the bin, a system of pulleys for the cable and a miniature electrically driven hoist and necessary control equipment. When the device is set into operation, the hoist motor runs in the direction which lowers the weight, until it strikes the material in the bin and the cable slackens. This slackening allows a mercury switch to tip, automatically reversing the motor for a definite period determined by a time-delay switch. Thus, regardless of the level of material in the bin, the weight is always lifted a definite distance above the material before the cycle reverses and the weight is again lowered. A level indicator outside the bin and attached to the cable shows at the upper limit of its travel the actual level in the bin at that moment. To prevent over-filling of the bin, a limit switch is provided to operate a warning or start or stop motors when the level reaches a predetermined point.

Continuous Gas Indicator

A NEW continuous combustible gas indicator has been announced by Davis Emergency Equipment Co., 55 Van Dam St., New York, N. Y. The new system locates the analyzing cell immediately in the area to be tested. This avoids lag occasioned by long sampling tubes and permits almost instantaneous registration of the condition through electric wiring to the panelbox. The new instrument is of the thermal conductivity type with each analyzing cell a part of a complete wheatstone bridge circuit, the other part of which is located in the panel box. An



Bin with level indicator installed

important feature of the new indicator is provision of a warning should a filament in one of the analyzing heads burn out. A light immediately appears on the panel and a buzzer sounds. This equipment can be used for automatic control of ventilation at the point of sampling to reduce vapor-air concentration below a predetermined point. A recorder may be added if desired.

Paper Stock Pump

SUCCESSFUL operation on paper machine feed stock in excess of 6 per cent consistency is claimed for the new Model ST-P stock pump recently announced by Morris Machine Works, Baldwinsville, N. Y. Several new features are employed. An exceptionally large suction nozzle, an inclosed parallel-shrouded impeller with external wiping vanes and a vent to prevent air binding are important features. A propelling device known as a suction booster can be installed in the suction nozzle to prevent dehydration of extremely high consistency stock. Very nearly constant output is claimed under varying heads and in spite of the foaming characteristics of the stock. Sizes of 3 to 6 in. are available, for handling from 15 to 250 tons of paper per day at moderately low operating speed.

Compact Expansion Joint

A SIMPLIFIED, compact expansion joint for steam and hot water lines which is of the U-ring type, requiring no packing, has been announced by the American District Steam Co., North Tonawanda, N. Y. The expansion element consists of a series of welded U-rings of corrosion-resistant steel, welded to the steel body of the fixed element of the joint and to the movable sleeve so as to form a permanent seal between these two parts. The element is compressed half its total traverse for installation in the cold line. As the line expands under heat, compression in the element is relieved and converted into tension beyond the neutral point. The joint is guided at three points and provided with a limit stop to prevent over-travel.

Laminating Phenolic Plastic

THE LAMINATED PHENOLIC PLASTIC, Micarta, was first produced over 30 years ago. For a long time it was used almost entirely as an electrical insulating material and today 40 per cent of the output of Westinghouse Electric & Manufacturing Co.'s plant at Trafford, Pa., is consumed by the company itself in its manufacturing operations. However, this product is now in demand for numerous other purposes. In the process industries it is often used as a material of construction because of its chemical resistance and mechanical properties.

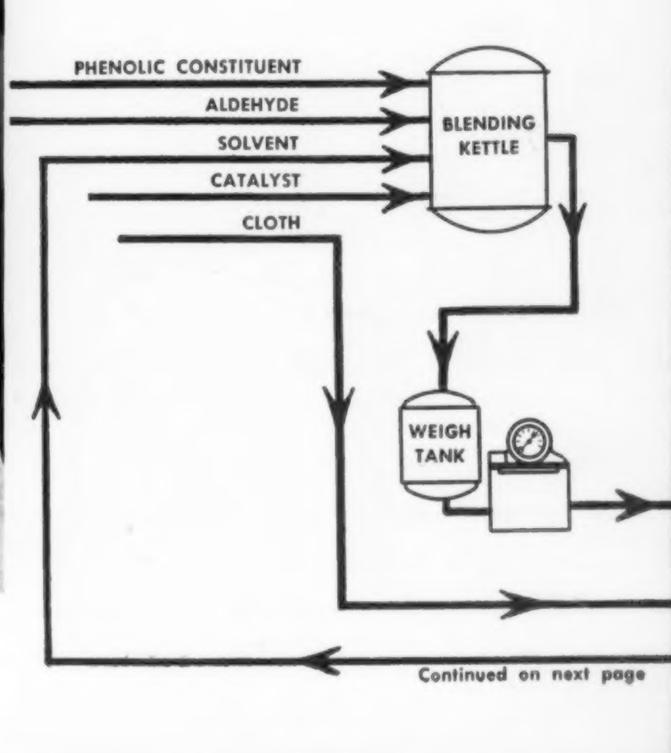
Basically Micarta is composed of but two elements, a synthetic resin and a filler. The resin, made chiefly of a phenol and formaldehyde, is used either as a powder or a liquid varnish with which filler materials are impregnated. The wide variety of filler or laminating material—including assortments of colored and decorative papers, silks, cottons, linens, and wood veneers—is a direct indicator of the number of applications for the finished product.

Liquid impregnation of the filler is accomplished automatically by a series of machines that run continuously. Rolls of cloth or paper pass through one resin bath after another until they have been dipped from one to four times. Between baths the material passes through steam-heated drying towers so that it is dried completely between dips.

Pressure used in thermohardening sheets or molded pieces varies from 1,000 to 5,000 lb. per sq. in., and is maintained by three large accumulator tanks, which are mounted on plungers connected with a pressure line. The two largest accumulators hold 170 tons of dead weights, maintaining an average pressure of 3,000 lb. per sq. in. on the hydraulic line.

In general, all grades and forms of Micarta are made by the same process, but the maze of different shapes, sizes, and finishes makes detailed production variations necessary. To simplify delineation in a flow sheet, the manufacture of only one style of Micarta —flat sheets for industrial use—is shown here.

Each raw material is tested carefully for impurities before it is placed in production.



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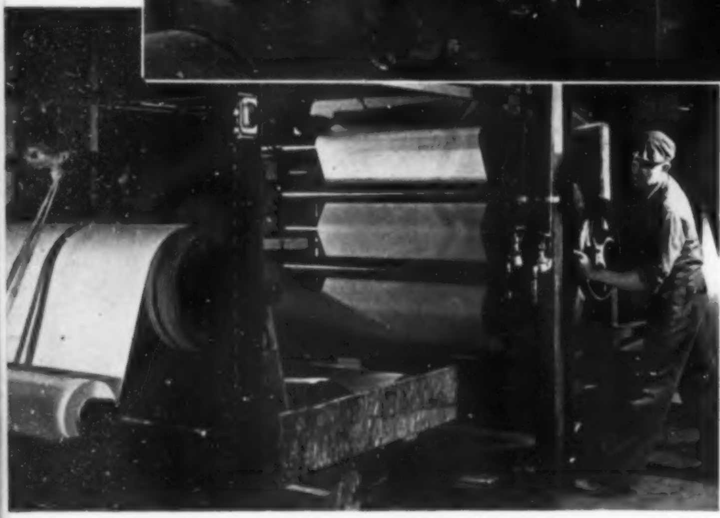
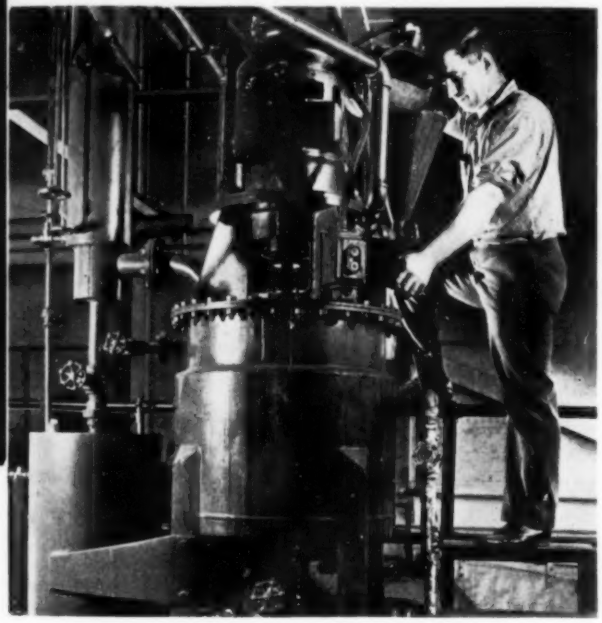
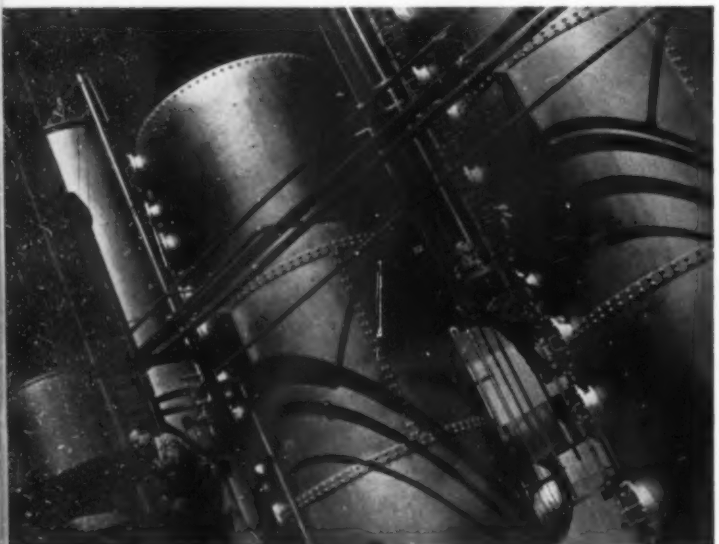


Raw paper in 100- to 1000-pound rolls, and in widths of 3, 4, or 8 feet, are fed at carefully controlled speeds in horizontal treating towers where the varnishes are absorbed, solvents are evaporated, and the impregnated paper is rerolled.

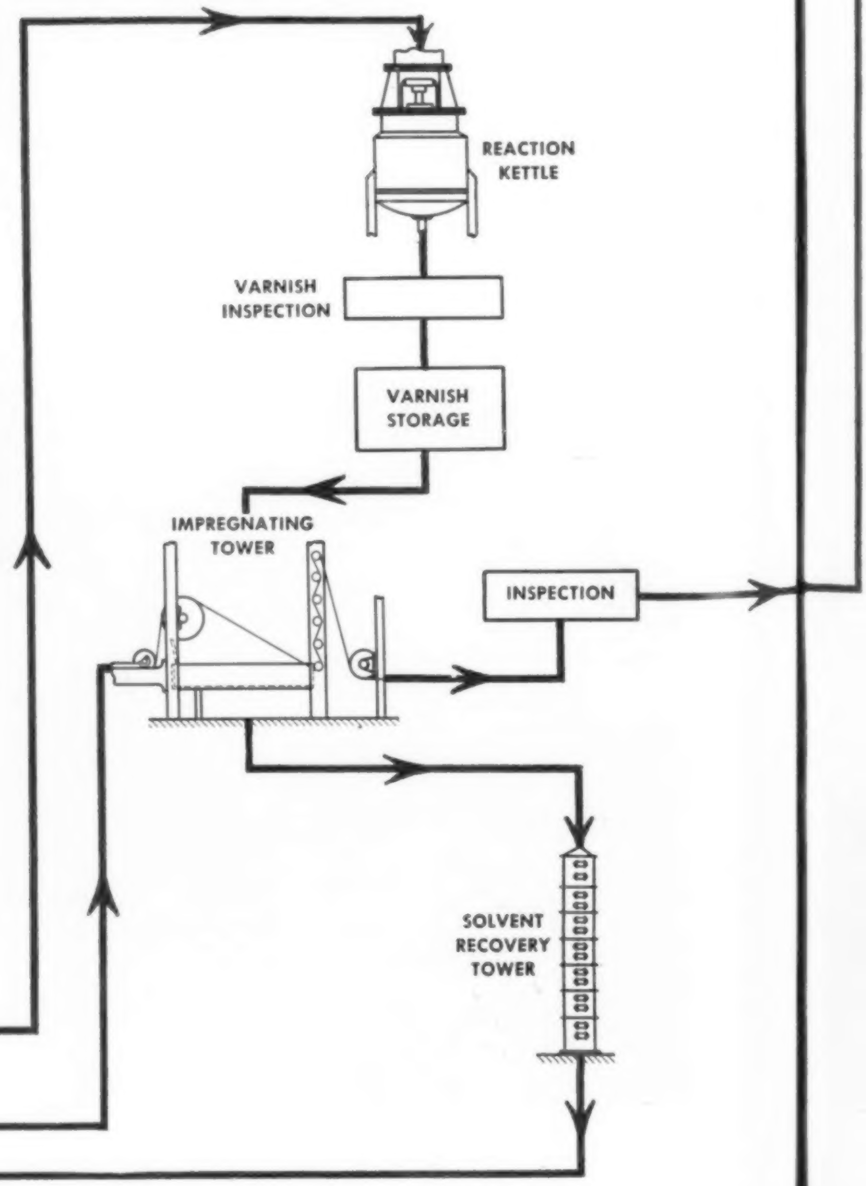
After blending in the proper proportions, raw chemicals are ready for varnish production in a reaction kettle.

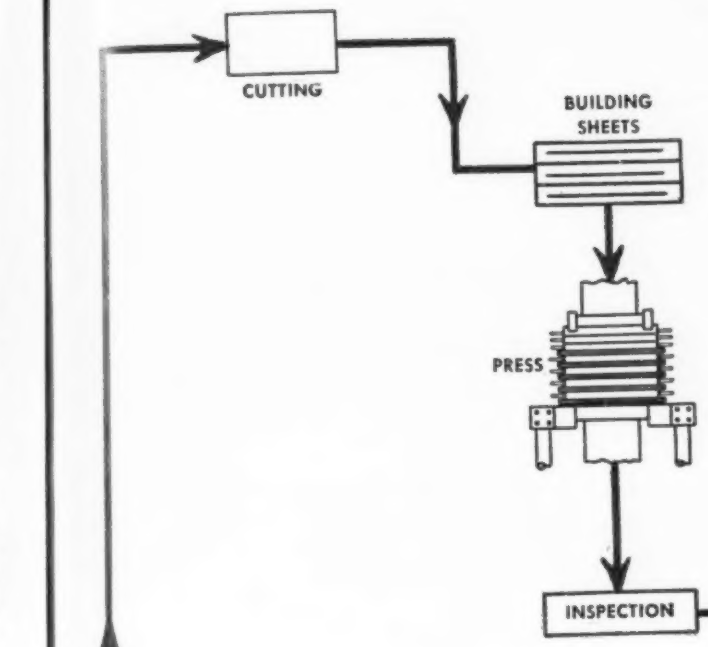


Varnish resins are made in steam-heated kettles by batch processes.

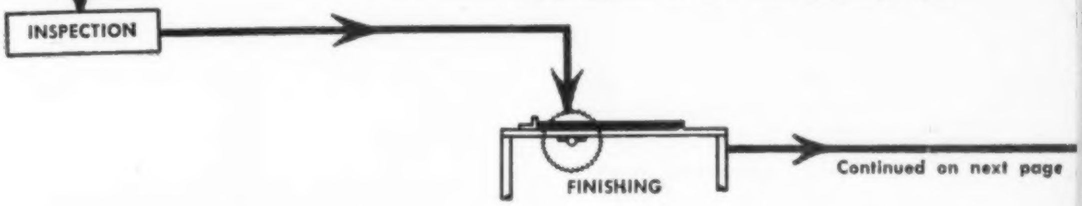


In tanks like this the volatilized solvents from treating towers are recovered and fed back into production as raw materials.





This hydraulic hot molding press is loaded with treated sheets of paper soon to be converted into 25 solid Micarta plates 3 feet by 3 feet. Controls are set to maintain proper uniform pressure, and temperature for the exact length of time. While this batch is being baked, the operators prepare a new batch of laminations for the next molding cycle.



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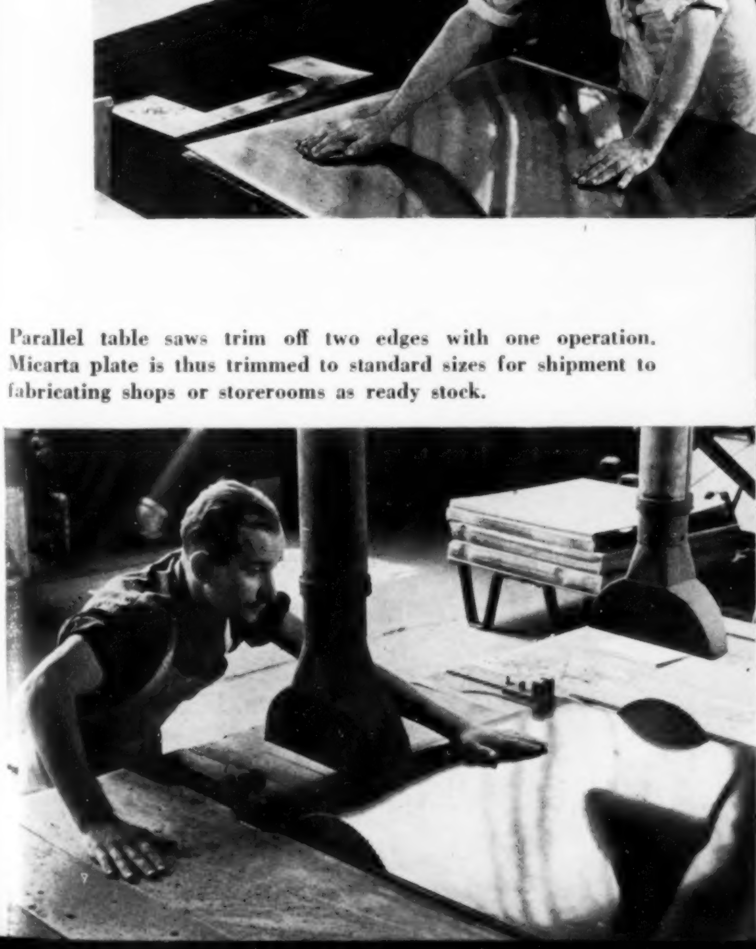
In the background the workmen "weigh up" the treated sheets to form the laminations for a certain desired finished thickness of Micarta Plate. (Finished thickness is about one-half the pre-molded thickness) In the immediate foreground a molded Micarta plate 37 inches square (untrimmed size) is stripped from the steel pressing plates. The ragged edges consist of excess synthetic resin which has flowed from the laminations during the hot molding operation.

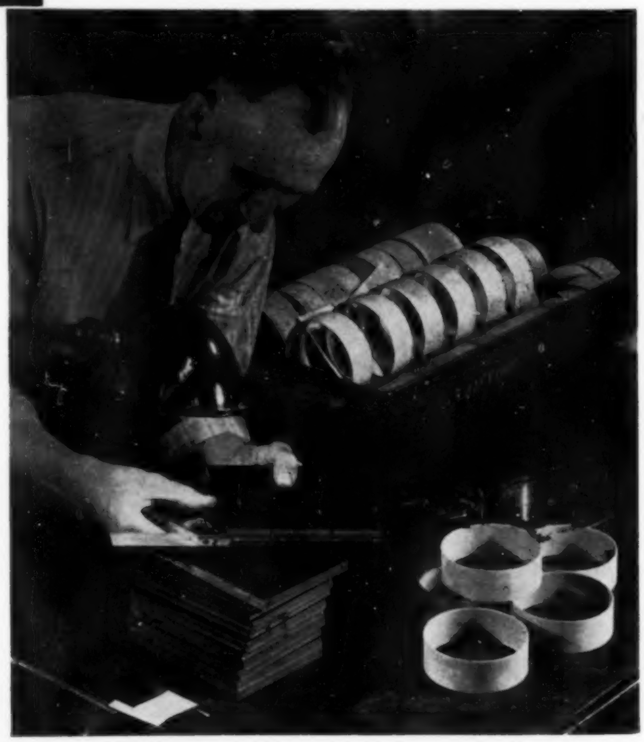
Parallel table saws trim off two edges with one operation. Micarta plate is thus trimmed to standard sizes for shipment to fabricating shops or storerooms as ready stock.

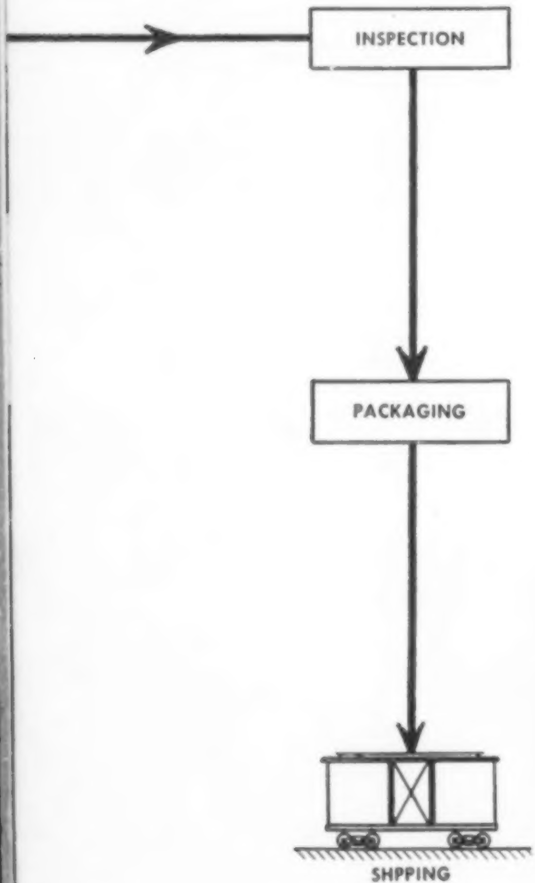


Skilled operators fabricate Micarta into finished pieces ready for immediate installation in the field.

Micarta Plate is inspected quickly and accurately with precision instruments built for the purpose. Here a micrometer shows on a large dial graduated to indicate thousandths of inches the plate thickness at any point on the entire area.

Before being turned over to the packers for shipment the cut and machined Micarta is given a final inspection for accuracy of dimensions so that each piece is approved as being exactly in accord with the customers drawings and specifications.





Loading platform in the shipping department where Micarta in thousands of sizes and shapes is packed in boxes, crates, and rolls, for shipment to every industry the world over.

Packaging Conference Will Be Held in New York

Alvin E. Dodd, President of the American Management Association, has announced a complete program for the 10th Conference on Packaging, Packing and Shipping to be held concurrently with the 10th Packaging Exposition at the Hotel Astor, New York, March 26 to 29, under the sponsorship of the Association.

A feature of the program this year will be a packaging clinic which will be conducted by Irwin D. Wolf, vice president of the American Management Association and donor of the Wolf Trophy for excellence in packaging. Mr. Wolf will be assisted by a clinic panel drawn exclusively from the membership of the Society of Designers for Industry and will include such prominent designers as Egmont Arens, Clarence Cole, G. W. Blow, Tom D'Oddario, Frank Gianninoto, Clarence Hornung, Martin Ullman, Georges Wilmet, Bond Morgan and William O'Neil.

Speakers will include Inez La Bossier, New Jersey Home Economics Extension Service; Joseph Givner, Sears, Roebuck & Co.; Howard Ketcham, Howard Ketcham, Inc.; A. Q. Maisel, *Modern Packaging*; D. S. Hopping, Celluloid Corp.; W. R. M Wharton, U S. Department of Agriculture; C. W. Browne, U. S. Printing and Lithograph Co.; Dr. Frank Campins, National Starch Products, Inc.; W. B. Lincoln, Jr., Inland Container Corp.; and G. T. Henderson, Hinde & Dauch Paper Co.

Brazil Will Use Coffee To Make Plastics

A report from the American Consulate General at Sao Paulo states that the Brazilian National Coffee Department has recently purchased a small plant in which experiments will be conducted in connection with the production of plastics from coffee. Arrangements have been made to obtain the requisite equipment in the United States and it is expected that operations will begin within a few months of its delivery.

The Coffee Department for some time has had under observation the experimental conversion of coffee into plastics invented and developed in the United States. It is reported that the process is capable of being developed along economic lines for commercial purposes. The sponsors of the Brazilian project claim that a 60-kilogram (132 pounds) bag of coffee will produce 45 kilograms (99 pounds) of plastic material and about 1¼ gallons of oil, and that this plastic material mixed with rubber, carnauba wax or other materials produces a satisfactory plastic.

It is claimed that the coffee plastic is not flammable, is highly resistant to acids, alkalies, compounds, oils and fruit acids and that it can be worked and polished. It is further claimed that the oil extracted from the coffee can be utilized successfully in the manufacture of soap, paints and wood preservatives with still other uses possible.

Dow Chemical Co. Buys Site For Plant in Texas

At a meeting held in Midland, Mich., on March 7, the directors of the Dow Chemical Co. authorized the purchase of approximately 800 acres of ground at Freeport, Texas, from the Freeport Sulphur Co. The land has about three miles of harbor frontage and the Dow Chemical Co. will proceed with the construction of a plant if the contracts now pending are satisfactorily concluded.

William Campbell Fellowships in Metallurgy

Through the bequest of the late William Campbell, for many years Howe Professor of Metallurgy at Columbia University, several Fellowships have been established. They are awarded primarily for graduate study and research in the field of metallurgy. The stipend of each Campbell Fellowship is fixed at the time of award by recommendation of the Campbell Fellowship Committee and will normally be an amount sufficient to meet the necessary living expenses of the incumbent of the fellowship.

Applications accompanied by certified transcripts of academic records, statements of proposed research projects and proposed fields of graduate studies have been filed with the Secretary of the University.

Chemical Engineers Club Formed at Charleston

The Chemical Engineers Club of Charleston, W. Va. was formed in February at a meeting of engineers from Kanawha Valley industries. R. K. Turner of Carbon & Carbide Chemical Corp. was elected chairman. Other officers are W. T. Nichols, Westvaco Chlorine Products, vice-chairman and J. R. Williams of E. I. du Pont de Nemours & Co., secretary-treasurer. Members of the executive committee are J. S. Beckley of du Pont, R. L. Sibley of Monsanto and J. B. Pierce of Barium Reduction.

Membership in the club is confined to active, associate, and junior members of the American Institute of Chemical Engineers. At the next meeting R. D. Webb of Carbon & Carbide will speak on "Instruments and Automatic Control in Chemical Manufacturing."

Process Engineers to Discuss Gas Drying

Increasing interest in the drying of air and gases by chemical means is recognized in a symposium on the drying of such materials which is to be sponsored by the Process Industries Division of the American Society of Mechanical Engineers and presented by the Metropolitan Section of that society on Mar. 19. The meeting will be held at 7:30 in the evening in Room 502 of the Engineering Societies Building in New York.

The symposium, which has been arranged to cover latest developments in several phases of chemical drying of gases, is to consist of three papers and considerable prepared discussion. James C. Patterson, manager of the dehydration division of the Carrier Corp., Syracuse, N. Y., will give a paper dealing with the use of silica gel in air drying. E. A. Windham, of the air conditioning division of Surface Combustion Co., Toledo, Ohio, will discuss the use of lithium chloride solutions for this purpose. G. L. Simpson, of the Pittsburgh Lectrodryer Corp., Pittsburgh, Pa., will take up the application of alumina gel in gas and air dehydration problems.

Electrochemists Will Meet At Wernersville in April

The Spring meeting of the The Electrochemical Society, Inc., will be held at Galen Hall, Wernersville, Pa., on April 24–27. The program arranged for the meeting divides activities among three main scientific-technical sessions. One will be devoted to electric steel, another to progress in electrodeposition and the third to papers on miscellaneous electrochemical subjects. A session for young engineers is scheduled for the afternoon of April 27.

Dr. A. Kenneth Graham who heads the local committee of arrangements has planned trips to various electric steel and other plants in Reading and vicinity. A trip to the model town of Hershey has been arranged for the ladies attending the meeting.

NEWS FROM WASHINGTON

Washington News Bureau
McGraw-Hill Publishing Co.
Paul Wooton, Chief

TRADE agreement negotiation by Secretary Hull was given three years extension of life by a closely divided House vote in late February. Thus the Administration won one of its major objectives so far as the House is concerned. But the victory was a narrow one, especially on the ballot as to whether Senate approval would be required in the future as it is for treaties. The Senate battle remains to be fought. It will be a bitter one.

Congress might not have granted this pet of Mr. Hull's another life if it had thought that there was any chance of further cuts in duties. Some members state frankly that they want to give plenty of rope (tariff rope) in the hope that Secretary Hull will help hang the New Deal. Such critics include old-line Democrats as well as hopeful Republicans.

Perhaps the real issue will be crystallized during Senate debate. It appears largely to center around the issue as to whether one man should have all the authority of tariff making. Neutral observers, if there be any, realize that Senate ratification of agreements would be equivalent to the denial of any real authority for negotiation. Thus they have been seeking a plan of board or commission action. However, that middle course displeases partisans of both extremes and is too reasonable to have any chance of enactment. If the President continues to put every political force available back of the Agreements program, even an unfriendly Senate will probably vote his way. As frequently emphasized in this column final votes on this question are cast by Senators and Representatives with a view to influencing the voters' actions at the polls next November. The vote in Congress has little or no relationship to what the member of Congress thinks is good for the country.

No Court Review

Fact finding is a job of the administrative agencies of the government. The Supreme Court says that it is not either the duty or the privilege of the federal courts to determine the correctness of the fact finding or to substitute judicial judgment for administrative judgment.

There was no dissenting voice on the Supreme bench when this finding regarding a decision of National Labor Relations Board was handed down on the mid-February decision day. The Court ruled that the Board was itself the agency designated by Congress to pass on the evidence, and that it had the final right to draw conclusions from conflicting evidence before it. The Court even went so far as to say "Whether this court would reach the same conclusion as the Board from the conflicting evidence is immaterial and the court's disagreement with the Board could not warrant the disregard of the statutory division of authority set up by Congress".

All this increases the desire of many Congressmen and Senators more fully to regulate the procedures of independent boards and commissions. However, the administration will fight to the last ditch against enactment of the Logan-Walter bill or of any other form of bill that would provide judicial authority over these alphabetic agencies set up by the planners during the last seven years. The outcome of the fight is problematical and of large political significance for the next campaign.

Escaping Over-Time Burden

From the start the Wage and Hour Division has insisted that companies must not cut wages per hour to avoid the over-time rate of $1\frac{1}{2}$ times normal, even though the result may be an hourly rate far above the legal minimum and a weekly pay equal to or better than formerly. The Wage and Hour Division has now gone to the court in a suit against the Carleton Screw Products Co. of Minneapolis.

The Wage and Hour Division states its case in a news release of February which includes the following pertinent comment:

"In our opinion an employer who will continue to work his employees in excess of 42 hours after October 24 (1939) for the same salary they now receive but who takes the trouble to manipulate the rates of pay in order to adopt a rate upon which he may calculate the time and a half, without incurring any additional labor cost, stands in no better position than the employer who simply and frankly disregards the overtime requirements of the Act."

The real issue in the case is apparently going to be whether or not this interpretation of the spirit of the law can be supported also by the letter of the law, persuasively enough to convince the judge. In other words, can this law be made into a spread-work measure as well as a minimum-wage-maximum-hour requirement? This or some similar case must ultimately go to the Supreme Court to insure finality of interpretation.

Importers Become Exporters—Washington notes that certain chemical firms formerly importing from Germany and other now ineccessible trade regions have radically changed their business policies. These former importers now buy American products for shipment to other countries, mainly Latin America. Apparently the German principals are trying to retain control of their South American markets by this plan. If they can use their United States agents in this fashion, they may be able to pick up the business for direct shipment from Germany later. Officials are wondering whether American chemical manufacturers whose goods are thus controlled by Central European agencies would not do better to insist on becoming direct suppliers of the Latin trade. If United States companies knowingly get involved in this German business, they may find themselves on the British blacklist.

Too Little Concentrated Fertilizer—Uncle Sam wants more concentrated fertilizer to use in the soil conservation program than both commercial makers and TVA are prepared to supply. Bids opened in late February offered only 13,000 tons out of a requested 25,000. Prices on this triple-super ranged from 55 cents per unit in Florida to 73 cents per unit for Maine delivery, with 5 to 8 cents per unit extra for bagged delivery. Apparently Secretary Wallace has at least temporarily exhausted the capacity of the country for making this 45 to 48 per cent superphosphate. Soil conservation will, therefore, have to be accomplished with normal concentrations of 16 to 20 per cent goods.

Cotton For Paper—The Department of Agriculture is going to assist technically, and to some extent arrange subsidy which may help high-grade writing paper manufacturers in using some low-grade cottons for paper making. The objective is greater cotton consumption. One effect would be building a higher rag content in the paper without more rags. Co-operating are the Division of Marketing and Marketing Agreements of A.A.A. and the Writing Paper Manufacturers Association.

Soviet Embargo—Uncle Sam would love to meet John Bull's wish that we embargo exports from United States to Russia that would be helpful to the Reds or perhaps even to the Nazis. The moral embargo wanted will not be difficult to arrange in an extra-legal plan for rubber, tin, and other strategics. But the pressure exerted politically to prevent food movements is hard to resist in Washington. Unless the Soviet becomes a declared belligerent, the President is not likely under the Neutrality Act to stop all goods movement to that part of the world. Politics dictate these foreign decisions irrespective of sentiment, and often with winking at the law.

Gypsum Inquiry—Apparently the gypsum products industry has the unenviable distinction of being the group selected for early action by the Department of Justice. The various factors involved in the fixing of prices are going to have critical review in the case recently initiated. Anti-monopoly officials hope to establish principles of general application regarding pricing of such products of chemical process industry as are used in construction. If they make their ideas stick in the courts, many other products not involved in the building business will have to walk the same chalk-line in pricing and selling.

GERMANY DEVELOPS NEW SYNTHETIC FIBER TO POINT OF MASS PRODUCTION

From Our German Correspondent

ACQUISITION of I.G. Farben's "Buna" synthetic rubber patent rights for the United States by Standard Oil Co. of New Jersey is viewed with satisfaction by German manufacturers. They feel that Standard's announcement that it will construct a plant costing between $1,000,000 and $1,250,000 with a yearly capacity of 2,000 tons of synthetic rubber is a vindication that their process, developed with the cooperation of Standard engineers, is sound and can become commercially feasible even in a country which can get natural rubber. Production costs, it is hoped, can be kept down to 20 cents a pound, which approximates the present price of natural rubber. To make the United States completely self-sufficient in rubber, it is estimated that it would cost from $75,000,000 to $100,000,000 to supply the equivalent of the 560,000 short tons of crude rubber, costing $175,000,000, which had to be imported last year.

According to reports, the American process will differ slightly from the German in that it will use oil instead of coal as a base. I.G.'s original plant in Germany is still using coal and lime, but a second plant now under construction will start directly with acetylene resulting as a byproduct in synthetic gasoline manufacture. The Reich's production has now reached the stage where some "buna" is being exported.

The latest development in fibers in the Reich is the fully synthetic "Pe-Ce Faser" (P.C. fiber). Made from coal and chalk derivatives, the new fiber, whose name "P.C." is an abbreviation of polyvinyl chloride, is now ready for mass production by I.G. Farben. Although silence is maintained as to production costs, the claims for the new fiber are impressive. Stronger than plant and animal fibers, it is not only waterproof, but acid-proof, non-flammable, highly elastic, and will serve as a good insulator for heat and electricity.

Tests have indicated that it will be satisfactory in chemical plants for use as filter cloth to replace cotton and wool filters, since its durability is claimed to be six to ten times greater. It is claimed to outlast nitro cloth by three to five times and some materials used in filtration of especially aggressive chemicals by thirty to fifty times. Because it is easier to clean, it will be used to some extent also to replace stone filters. Since the P.C. fiber's tensile strength is claimed to be higher than that of steel, it is hoped to use the material as a substitute for iron bars in reinforced concrete.

In the meantime, "Vistra" fiber, the regular "cell wool," is now entering its twentieth year of production. Whereas the official name "Zellwolle" was coined in 1935, the trade name "Vistra" dates back to the world war. The origin for the name of this as well as of many of the newer chemical products is interesting. It is formed from the combination of the mottoes of the two firms which first combined to manufacture it: "Vis" from "Si vis pacem, para bellum" ("if you want peace, prepare for war") of the Köln Rottweil A.G.; and "stra" from "Per aspera, ad astra") ("through difficulties to the stars") of Dynamit A.G., formerly Nobel. The former firm began manufacture in 1920 in its powder factory Pulverwerk Premnitz, and by the following year had produced 100,000 kg. of vistra fiber to replace the unsatisfactory war time "Stapelfaser," a staple fiber made by cutting up rayon. By now many different types have been developed, some of which will probably be retained even when normal access to natural fiber markets is reestablished.

Besides shortages of copper, wool, tin, and iron ore, the maintenance of an adequate oil supply continues to be one of Germany's chief war time problems. Much speculation has arisen concerning the struggle to obtain control of Rumanian resources, the Reich using the instrument of economic and potential military pressure, while the Allies are resorting to financial pressure. Rumanian production reached a peak in 1936 with 8.7 million tons of oil, and has declined steadily from 7.1 million tons in 1937, to 6.6 million tons in 1938, to 6.2 million tons in 1939. The decline is due to the exhaustion of reserves and limited exploratory operations resulting from the Rumanian government's restrictive policies. Last year the British and Dutch controlled wells produced 39.8 per cent of the output, the French 16.6, the American 12.5, the Belgian 14.5, the Rumanian-owned wells 9.7, Italian 5.5, and those of other nations 1.4 per cent. Germany, which had some financial interest in Rumanian oil production before the world war, was ousted by the peace treaties, although she has imported a considerable share of the oil output. In 1935 the Reich took 1.4 million tons of Rumanian oil; in 1936, 1.7 million; in 1938, 1.0 million, and in 1939, 1.2 million tons. It is difficult to ascertain what the Reich is getting this year, although Rumania agreed recently to sell Germany 1.68 million tons yearly. It is said that delivery is behind schedule and that there has been some sabotage in connection with these deliveries. Nevertheless, Rumanian general exports to Germany reached a value of 1160 million lei in December 1939 as against 394 million lei in December 1938.

Within Germany there have recently been changes in the petroleum industry.

The German Petroleum Co. (Deutsche Petroleum A.G.) and Nova Oil and Fuel Co. of Vienna have been absorbed by the German Erdoel A.G. Stockholders will receive 145 per cent of the par value of their shares. Last year French owners sold their 87 per cent controlling interest in the capital stock of the Nova Co. to the Erdoel group.

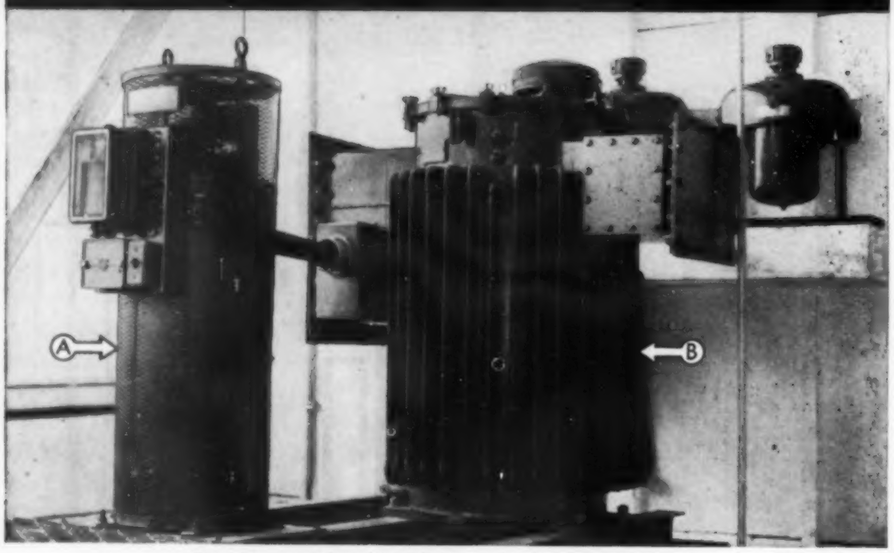
The Reich is also carefully watching Russia's attempts to push production in the Baku. The appointment of L. M. Kaganovitch, one of Stalin's closest collaborators, to supervise the Soviet oil industry emphasizes the Soviet's efforts. In 1937 the Baku produced 23,250,000 tons of oil, and its production should reach 27 million tons by 1942, and is capable of considerable further expansion. The Soviets, of course, need larger supplies themselves, but some of this oil may be available for Germany. Because of the Baku's remote position, the transportation of oil, especially in winter, occasions great difficulties.

In connection with this and other Russian transport/ problems, the announcement is of interest that by April of this year direct waterway connection between the Baltic and Black sea will be established for the first time. Reports from Moscow state that work on the canal to connect the Bug and Pripet rivers with the Dnjepr is progressing rapidly, and that the new waterway will make it possible to bring oil and other heavy freight direct from Odessa, the Ukrainian Black Sea port, to Danzig on the Baltic.

Rail connections between Russia and Poland and Germany are being facilitated by the change, almost completed, of the gage of the railroad tracks in eastern Poland to conform with that of the German railroads. The flow of imports, chiefly mineral oils and grains, from the Soviet to Germany during the first ten days of January was equal to that of the entire month of December.

Simultaneously plans are being rushed to extend the "Reichs-autobahn" eastern super-highways system with construction of a direct Berlin to Moscow highway, probably via Landsberg, Schneidemuehl, Bromberg, and Lyck, and connecting with north-south highways to Danzig, Breslau, and Vienna. Soviet Russia is also planning to participate actively in the important "Ost-Messe," eastern fair, held in Koenigsberg in August. Fifteen nations and 6,500 firms exhibited at the Leipzig spring fair held March 3 to 8, with three additional days for the technical and building fairs. The Achema meeting has been canceled.

German industry has lost two of its leaders through the death January 22 of Otto Wolff, at the age of 58, director of the Vereinigte Stahlwerke and other concerns, for years an outstanding figure in the iron and steel industry. The chemical industry also lost one of its leading men in the passing on February 2 of Walter vom Rath, at the age of 83. Dr. vom Rath became director of the Frankfurt-Hoechst dye plant Meister Lucius and Bruening (fused in 1925 with I.G. Farben) in 1890, and had been active until his death in this and a number of other concerns.



Japan Will Invite American Bids for Equipping Coal Liquefaction Plant

Special Correspondence

CONFIDENT that Washington's recent "moral embargo" on exports of gasoline refining equipment and blue-prints therefor to nations that bomb civilians does not apply to coal liquefaction plants (which mainly produce heavy oils), the Sumitomo concern has decided to invite bids from American manufacturers on a $7,500,000 hydrogenation plant, originally to be supplied by German makers.

The Imperial Fuel Industry Co., the state-controlled ¥300-million holding corporation for the development of Japan's synthetic oil industry, has already signified its consent to the change of the import plan. Ryoichi Kawamoto, of the Sumitomo Metals Co., has been sent to the United States to make the necessary arrangements.

The "moral embargo" has totally upset the plans of the East Asia Fuel Industry Co., a ¥50,000,000 concern established last summer at the behest of the Japanese Army. The concern was to produce aviation fuel of high octane rating by one of the new American catalytic cracking processes, and its technical experts were sent to the United States to buy plans and equipment.

Washington's denunciation of the American-Japanese Treaty of Commerce and Navigation of 1911, effective from January 27, has removed the legalistic obstacles to the enforcement of the long-mooted embargo on shipments of American war materials to Japan.

There are very few chemicals which may be classed outright as war chemicals. Japan does not import any amounts of compounded explosives, and none from the United States. However, if the United States should take the line that Japan's recent large imports of acetone and other solvents as well as of coaltar distillates and dyestuff intermediates come under the heading of munitions imports, an embargo would seriously affect Japan, inasmuch as practically all of these imports are supplied by the United States, particularly since Germany dropped out of the market.

Probably not one tenth of a per cent of all cotton which Japan imports is used in the manufacture of explosives. Japan's natural camphor is a much handier starting material, for instance in the manufacture of cordite.

There are very few other chemicals which Japan would be afraid to have embargoed by the United States, and these are actually under "moral embargo," though probably an actual embargo would be more effective.

Trade statistics for 1939, just issued by the Department of Finance in Tokyo, reveal sweeping changes in Japan's foreign trade in chemicals last year. The changes may be traced partly to the

European war, partly to Japan's own "incident," and in many cases to both.

The aggregate total of imports of drugs, chemicals, pharmaceuticals and explosives for the year dropped to ¥170.6 million, compared with ¥181.8 million in 1938 and ¥251.8 million in 1937. Yet, imports of some typical war chemicals recorded substantial increases. Imports of acetone (presumably used as solvent in explosives manufacture) increased from 423,634 kin in 1938 to 4,617,765 kin in 1939. (One kin equals 0.6 kg.) Unspecified "chemical products derived from coaltar distillates" rose in value from ¥2.2 million to ¥2.6 million, but imports of other unspecified compounds of chemicals dropped from ¥31.5 million to ¥16 million. Reflecting the sanitary effects of Japan's military operations in malaria infested areas in South China, imports of the sulphate and hydrochlorate of quinine jumped from 10,298 kg. in 1938 to 48,942 kg. last year. Pre-"incident" imports averaged 3,000 kg.

The effect of the Allied two-way blockade is already apparent in some typical German trade items. Imports of ammonium sulphate dropped to 82,000 tons, from 296,000 tons in 1938. Imports in the group "dyes, pigments, coatings and filling matters" recorded a slight increase over 1938, but remained 80 per cent below purchases in 1937.

How far has Japan succeeded in mobilizing the resources of the "yen bloc" (Manchuria and China) for her chemical industry, and thus in cutting down her gold-draining expenditure on imports from world markets?

Figures indicate that Japan has moved away from this cherished goal rather than in the other direction. In 1939, Japan got only 82,000 tons of ammonium sulphate out of Manchuria, compared with 126,000 tons in 1938, hence the anticipated trend has been reversed.

The yen bloc's share in Japan's imports of caustic soda, soda ash and natural soda increased from 41,000 picul in 1938 to 96,000 picul in 1939, due to the resumption of operations in China.

Japan is also still far from intra-bloc self-sufficency in industrial salt on which her large alkali industry depends. Total imports in 1938 (the latest year for which detailed figures are available) amounted to 23,800,000 picul, of which Manchuria furnished 5,800,000 and China 8,400,000, making a total contribution from the non-colonial yen bloc of 142,000 picul, or 60 per cent of the aggregate import total.

On the export side, a striking recovery was witnessed in shipments of vegetable oils, which increased from 388,000 picul in 1938 to 674,000 picul last year. The recorded value of these exports doubled from ¥8.6 million to ¥17.3 million. Exports of fish and animal oils, however, dropped from 436,000 picul in 1938 to 167,000 picul last year, although on a monetary basis the loss was but slight, due to higher prices. Shipments of hardened oil, from fish and other, increased from 349,000 picul to 364,000 picul.

Columbia Alumni Chemists Elect Officers

Dr. Donald Price, chief research chemist for the National Oil Products Co., Harrison, N. J., is the first president of the newly organized Chemists Alumni Association of Columbia University. Dr. Harry L. Fisher, associate director of research, U. S. Industrial Alcohol Co., was elected vice-president and Wendell G. Fogg, chief chemist of Air Reduction Co., Stamford, Conn., secretary-treasurer. Election of officers was held at the January meeting, but the announcement was withheld until all alumni were notified.

There are believed to be more than 3,000 alumni eligible for new alumni group. The organization of such an association was voted at the Columbia luncheon held in Boston during the American Chemical Society meeting last September.

Acetylene Association Will Meet in Milwaukee

The 40th Convention of the International Acetylene Association is to be held in Milwaukee, on April 10–12. Convention Headquarters will be at the Schroeder Hotel.

The program will include a scientific forum on oxyacetylene cutting of metals, a series of round-table discussion meetings, and, on each of the three days of the convention, a group of technical sessions, at which will be presented many interesting papers by outstanding technical men and experts in applications of the oxy-acetylene process of welding, cutting, and heat-treating.

Sixth Conference on Glass Scheduled at Urbana

A Glass Conference, the sixth in the series which have been given from time to time under the joint auspices of the Department of Ceramic Engineering at the University of Illinois and the Chicago Section of the American Ceramic Society, will be held at Urbana, Ill., on May 10–11.

A program of especial interest to plant operators and glass technologists is being prepared. This will be announced at a latter date and in due time forwarded to all who have attended previous sessions. Anyone interested in the Conference who has not attended the meetings is invited to inform the Department to that effect so that his name may be placed on the mailing list.

Research Fellowships in Coal and Non-Metallics

In cooperation with the U. S. Bureau of Mines, the University of Washington is offering four fellowships for research in coal and non-metallics. Fellows begin their duties on July 1 and continue for twelve months. Payments under a fellowship are made at the end of each month and amount to $720 a year.

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MODERN PIONEERS

On the Chemical Engineering Frontier

LAST SUMMER the National Association of Manufacturers conceived a unique plan for observing the 150th anniversary of the founding of the American Patent System and at the same time honoring the country's outstanding inventors, engineers and research scientists. A distinguished committee consisting of Dr. Karl T. Compton, Chairman and President of Massachusetts Institute of Technology, Dr. F. R. Moulton, Permanent Secretary of the American Association for the Advancement of Science, Dean George B. Pegram, of the Graduate Faculties of Columbia University, Dean John T. Tate of the University of Minnesota, Dr. Edward R. Weidlein, Director of Mellon Institute, and Dean Frank C. Whitmore of Pennsylvania State College, was assigned the task of selecting those men who, through their inventions and research, had made significant contribution to the creation of new jobs, new industries and improvements in the standard of living. There were 1,026 such men nominated by manufacturers, engineers and scientists for recognition as "Modern Pioneers on the Frontiers of American Industry." From them the Committee of Award selected 572 whom they recommended for this recognition by the National Association of Manufacturers. Particularly outstanding Modern Pioneers were recommended for 19 national awards. The chemical and engineering professions may well be proud of the fact that more than one-third of the selections were made from men within their own ranks.

Chem. & Met. takes pleasure, therefore, in presenting herewith the names and in many instances the photographs, of those Modern Pioneers who are most closely identified with the advances of the process industries.

MODERN PIONEERS IN CHEMICAL PROCESS INDUSTRIES

National Pioneers

LEO H. BAEKELAND, Bakelite Corporation
WILLIAM M. BURTON, Standard Oil Co. of Ind.
WILLIS H. CARRIER, Carrier Corporation
WILLIAM D. COOLIDGE, General Electric Co.
F. G. COTTRELL, Washington, D. C.
G. O. CURME, JR. Carbide & Carbon Chem. Corp., N. Y.
JOHN V. N. DORR, Dorr Co., Inc.
EDWIN H. LAND, Polaroid Corp.
IRVING LANGMUIR, General Electric Co.
HARRY STEENBOCK, University of Wisconsin
JOHN B. TYTUS, American Rolling Mill Co.
C. F. WALLACE, Wallace & Tiernan Co.

Nylon Group from duPont

WALLACE H. CAROTHERS, (Deceased)
WILLARD E. CATLIN
DONALD D. COFFMAN
WINFIELD W. HECKERT
BENJAMIN W. HOWK
GEORGE D. GRAVES
WILBUR A. LAZIER
JOHN B. MILES, JR.
WESLEY R. PETERSON
FRANK K. SIGNAIGO
EDGAR W. SPANAGEL

New York Area

FREDERICK M. BECKET, Union Carbide & Carbon Corp.
FRANK G. BREYER, Singmaster & Breyer
GARLAND H. B. DAVIS, Standard Oil Development Co.
CAMILLE DREYFUSS, Celanese Corp. of America
CARLETON ELLIS, Standard Oil Development Co.
COLIN G. FINK, Columbia University
HARRY L. FISHER, U. S. Ind. Alcohol Co.
WILLIAM N. GOODWIN, JR. Weston Elec. Instrument Corp.
MARTIN H. ITTNER, Colgate-Palmolive-Peet Co.
LESTER KIRSCHBRAUN, Flintkote Company
WALTER S. LANDIS, American Cyanamid Co.
ELMER C. SCHACHT, Behr-Manning Corp.
WILLIS R. WHITNEY, General Electric Co.
ROBERT R. WILLIAMS, Bell Telephone Labs., Inc.
ROBERT E. WILSON, Pan American Petroleum & Transport Co.
EARLE C. PITMAN, E. I. duPont de Nemours & Co. (Sharing in joint award)

Chicago Area

JOSEPH G. ALTHER, Universal Oil Products Co.
CARBON P. DUBBS, Universal Oil Products Co.
GUSTAV EGLOFF, Universal Oil Products Co.
WALTER GEIST, Allis-Chalmers Mfg. Co.
HENRY B. HASS, Purdue University
WILLIAM F. HENDERSON, The Visking Corporation
N. V. IPATIEFF, Universal Oil Products Co.
HARRY E. LABOUR, The LaBour Co.
EARL T. McBEE, Purdue Research Foundation
IRA E. McCABE, Mercoid Company
CARL S. MINER, The Miner Laboratories
JACQUE C. MORRELL, Universal Oil Products Co.
RAY C. NEWHOUSE, Allis-Chalmers Mfg. Co.
WILLIAM B. NEWKIRK, Corn Products Refining Co.
CARL PFANSTIEHL, Pfanstiehl Chemical Co.
THOMAS H. ROGERS, Standard Oil Co. (Indiana)
ERNEST H. VOLWILER, Abbott Laboratories
V. VOORHEES, Standard Oil Co. (Indiana)
CARY R. WAGNER, The Pure Oil Company

Philadelphia Area

NEWCOMB K. CHANEY, United Gas Improvement Co.
HENRY J. CREIGHTON, Swarthmore College
HERBERT W. DANDE, E. I. duPont de Nemours & Co.
CLYDE O. HENKE, E. I. duPont de Nemours & Co.
RUSSELL P. HEUER, General Refractories Co.
EUGENE HOUDRY, Houdry Process Corporation
MORRIS EVANS LEEDS, Leeds & Northrup Co.
CLARENCE H. THAYER, Sun Oil Co.
EDMUND M. FLAHERTY,
MAURICE V. HITT, E. I. duPont de Nemours & Co. (Joint award with Earl V. Pitman)
R. G. WOODBRIDGE, E. I. duPont de Nemours & Co. (Joint Award with Alfred L. Broadbent, Pasadena, Calif.)
HERBERT O. ALBRECHT
MERLIN M. BRUBAKER
OSWALD H. GREAGER
HORACE H. HOPKINS
JOHN W. ILIFF
WILLIAM W. LEWERS
FRANK A. McDERMOTT
GORDON D. PATTERSON
JOHN RICHARDSON, JR.
PAUL ROBINSON
HARRY R. YOUNG

Joint Award
HAMILTON BRADSHAW
EDGAR H. NOLLAU

Joint Award
ALFRED T. LARSON
DONALD J. LODER

Joint Award
ALLEN E. LAWRENCE
FREDERICK W. MILLER
All from E. I. duPont de Nemours & Co.

Rochester Area

WILLIAM HALE CHARCH, E. I. duPont de Nemours & Co.

WILLIAM C. GEER, The B. F. Goodrich Co.

K. C. D. HICKMAN, Distillation Products, Inc.

C. E. K. MEES, Eastman Kodak Co.

RAYMOND R. RIDGWAY, Norton Company

SAMUEL E. SHEPPARD, Eastman Kodak Co.

EUGENE C. SULLIVAN, Corning Glass Works

WILLIAM C. TAYLOR, Corning Glass Works

HENRY E. VanDERHOEF, Eastman Kodak Company

HANS T. CLARKE,

CARL K. MALM, Eastman Kodak Company (Joint Award)

MAURICE W. PHELPS, Solvay Process Corp. (Joint Award with William R. Barber and Albert Natwick of San Francisco)

Baltimore Area

WALTER A. PATRICK, Davison Chemical Co.

R. C. ROARK, U. S. Department of Agriculture (Joint Award with R. T. Cotton and Harry D. Young, St. Louis Area)

KARL TURK, SR.,

RICHARD H. TURK, The Porcelain Enamel & Mfg. Co. (Joint Award)

Boston Area

GUSTAVUS J. ESSELEN, Gustavus J. Esselen, Inc.

JOHN F. WHITE,

WILLIAM S. WILSON, Monsanto Chemical Co. (Joint Award)

CLESSON E. MASON, The Foxboro Company

S. W. ALDERFER,

HAROLD W. GREENUP, Firestone Rubber & Latex Prod. Co. (Joint Award)

Cincinnati Area

J. C. CARLIN, Gaither Chemical Works

HAROLD W. GREIDER, The Philip Carey Mfg. Co.

JEROME MARTIN, Commercial Solvents Corporation

ROBERT L. SIBLEY, Monsanto Chemical Co.

GAMES SLAYTER, Owens-Corning Fiberglas Corp.

L. A. STENGEL, Commercial Solvents Corp.

HAROLD W. deROPP,

H. C. HETHERINGTON, E. I. duPont de Nemours & Co., Inc. (Joint Award with A. E. Lawrence and F. W. Miller, Philadelphia area)

Cleveland Area

CARL L. BEAL, American Anode, Inc.

JOSEPH BECKER, Koppers Company

L. O. GRONDAHL, Union Switch & Signal Co.

RALPH E. HALL, Hall Laboratories, Inc.

WILLIAM J. HARSHAW, Harshaw Chemical Co.

JAMES F. LINCOLN, Lincoln Electric Co.

JOHN C. LINCOLN, Lincoln Electric Co.

MARVIN PIPKIN, General Electric Co.

CARL F. PRUTTON, The Lubri-Zol Corporation

WALDO L. SEMON, The B. F. Goodrich Co.

WILLIAM C. STEVENS, Firestone Tire & Rubber Co.

Detroit Area

HARRY C. MOUGEY, General Motors Corporation

JOHN F. OLIN, The Sharples Solvents Corp.

THOMAS A. BOYD, General Motors Corp.

THOMAS MIDGLEY, Ethyl Gasoline Corp. (Joint Award)

RONALD A. McGLONE,

STEPHEN J. ROSKOSKY, E. I. duPont de Nemours & Co. (Joint Award)

Hartford Area

FERNLEY H. BANBURY, Farrel Birmingham Co., Inc.

KARL E. PEILER, Hartford-Empire Co.

Los Angeles Area

EVALD ANDERSON,

W. A. SCHMIDT,

H. V. WELCH, Western Precipitation Corp., (Joint award)

Minneapolis Area

FREDERICK S. DENISON, Minneapolis-Honeywell Regulator Co.

San Francisco Area

ROBERT T. BOWLING, Wood Briquettes, Inc.

EDWIN L. OLIVER, Oliver-United Filters, Inc.

ERNEST J. SWEETLAND, Oliver-United Filters, Inc.

WILLIAM R. BARBER,

ALBERT G. NATWICK, Crown Zellerbach Corp., (Joint Award with Maurice W. Phelps, Rochester Area)

St. Louis Area

ROBERT M. BOEHM, Masonite Corporation

JOHN N. CAROTHERS, Monsanto Chemical Co.

WILLIAM H. MASON, Masonite Corporation

WILLIAM D. MOORE, American Cast Iron Pipe Co.

ERSKINE RAMSAY, Alabama By-Products Corporation

NATIONAL AWARDS
In The Chemical Process Industries

1. L. H. Baekeland. 2. W. H. Carrier. 3. W. D. Coolidge. 4. F. G. Cottrell. 5. G. O. Curme, Jr. 6. J. V. N. Dorr. 7. E. H. Land. 8. Irving Langmuir.

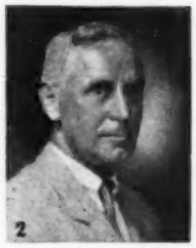
DUPONT NYLON RESEARCH GROUP

1. W. H. Carothers (deceased). 2. W. E. Catlin. 3. D. D. Coffman. 4. G. D. Graves. 5. W. W. Heckert. 6. B. W. Howk. 7. W. A. Lazier. 8. J. B. Miles, Jr. 9. W. R. Peterson. 10. F. K. Signaigo. 11. E. W. Spanagel.

★

REGIONAL AWARDS
In Chemical Process Industries

1. J. G. Alther, 2. F. H. Banbury, 3. Jos. Becker, 4. F. M. Becket, 5. F. G. Breyer, 6. J. C. Carlin, 7. H. J. Creighton, 8. C. P. Dubbs, 9. Gustav Egloff, 10. Carleton Ellis, 11. G. J. Esselen, 12. C. G. Fink, 13. H. L. Fisher, 14. E. M. Flaherty, 15. W. C. Geer, 16. Walter Geist, 17. L. O. Grondahl, 18. H. B. Hass, 19. W. F. Henderson, 20. V. N. Ipatieff, 21. M. H. Ittner, 22. H. B. Kline, 23. W. S. Landis, 24. W. H. Mason, 25. Thos. Midgley, Jr., 26. C. S. Miner, 27. R. C. Newhouse, 28. E. L. Oliver, 29. W. A. Patrick, 30. Marvin Pipkin, 31. T. H. Rogers, 32. W. A. Schmidt, 33. S. E. Sheppard, 34. E. C. Sullivan, 35. E. H. Volwiler, 36. C. R. Wagner, 37. R. E. Wilson, 38. V. Voorhees.



PERSONALITIES

George F. Scherer

✦ ARTHUR B. LAMB, professor of chemistry at Harvard University, has been appointed dean of the Graduate School of Arts and Sciences. He has been a member of the Department of Chemistry since 1905 with the exception of the years 1906–12, when he taught at New York University. He has been director of the chemical laboratory at Harvard since 1912.

✦ DONALD PRICE, chief research chemist for the National Oil Products Co., Harrison, N. J., is the first president of the newly organized Chemists Alumni Association of Columbia University.

✦ MERLE R. MECHAN, general superintendent of the Bayway refinery of Standard Oil (N. J.), has been appointed general manager of the company's refineries at Baltimore and Charleston. He will be succeeded at Bayway by his assistant, Donald L. Ferguson.

✦ LOUIS GARBI, specialist for the past ten years in cold and hot asphalt mixes, is again associated with the Pioneer Asphalt Co. He first joined Pioneer in 1910 as sales engineer shortly after graduating from Cornell University.

✦ LOUIS S. FRYER has been appointed production manager of the Industrial Rayon Corp. Mr. Fryer has been supervisor of plant procedures since 1931. He is a native of New York and a graduate chemical engineer of New York University. Before joining Industrial he was in the production and research departments of E. I. du Pont de Nemours & Co's rayon plant at Buffalo, N. Y.

✦ D. M. CURRY is now affiliated with the H. Kramer and Co., Chicago, as a member of the technical service staff. He recently resigned from the Development and Research Department of the International Nickel Co. with whom he had been connected for five years.

✦ WALTER I. NEVIUS, who for the past 18 years has been in charge of the engineering operations of the Commercial Solvents Corp., is now retained by that organization as consulting engineer. He is also available to act as consultant for other industrial organizations.

✦ JESSE T. LITTLETON, who for the past 20 years has headed the physics laboratory of Corning Glass Works, has been promoted to the newly-created position of assistant director of research.

✦ MICHAEL J. PRIGOTSKY has been awarded the annual Self-Improvement Prize established by W. W. Winship in 1929 and open to all members of the graduating class at Pratt Institute.

✦ IVOR GRIFFITH, dean of pharmacy and professor of theory and practice of pharmacy at the Philadelphia College of Pharmacy and Science has been appointed to the Advisory Board of Health of the Commonwealth of Pennsylvania.

E. G. Miner

✦ E. G. MINER, chairman of the board of the Pfaudler Co. was awarded the Citizens Medal for 1940 in recognition of his outstanding service to the city of Rochester, N. Y.

✦ CHARLES E. MAYETTE is now sales engineer for the Underground Steam Construction Co., Boston, Mass., subsidiary of E. B. Badger & Sons Co. He will be interested in installations of high-pressure and high-temperature piping.

✦ GEORGE F. SCHERER is now director of research for Merco Nordstrom Valve Co. Oakland, Calif.

✦ WALTER L. MAXSON has been appointed sales manager and chief engineer of Mining Machinery division of Allis-Chalmers Manufacturing Co.

✦ EARLE D. MOILES passed away February 5 from effect of pneumonia complicated by a heart condition. He was associated with the Merco Nordstrom Valve Co., a subsidiary of Pittsburgh Equitable Meter Co., and at the time of his death was manager of the Pittsburgh operations of the Valve company.

✦ LIONEL BROWN, head chemist for the Noblesville Milling Co., died February 2 in a local hospital from complications which developed following an operation the previous week.

✦ ROBERT C. CANTELO, for the past two years assistant professor of Chemical Engineering at West Virginia University, died on February 2 after an illness of approximately a month. In 1931, Dr. Cantelo joined the staff of the Deloro Smelting Company, Kingston, Ont., as assistant metallurgist and three years later went to the Canada Department of Mines.

CALENDAR

APRIL, 8-12, 1940, AMERICAN CHEMICAL SOCIETY, annual meeting, Cincinnati, Ohio.

APRIL 24-27, 1940, ELECTROCHEMICAL SOCIETY, annual meeting, Galen Hall, Wernersville, Pa.

MAY 13-15, 1940, AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, Buffalo.

MAY 27-31, 1940, AMERICAN PETROLEUM INSTITUTE, mid-year meeting, Fort Worth, Tex.

AUG. 20-23, TECHNICAL ASSOCIATION OF THE PULP & PAPER INDUSTRY, fall meeting, Olympic Hotel, Seattle, Wash.

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CINCINNATI, Central Parkway at Walnut St.	SAN FRANCISCO, 116 New Montgomery St.
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Readers' VIEWS and COMMENTS

More on Flow Through Bins

To the Editor of Chem. & Met.:

Sir:—Mr. Sandstrom's article in your January issue, on avoiding clogged bin hoppers, was very interesting and raised certain points which deserve attention from a little different angle.

Retaining Wall Analogy

In 1895 the French officer, Leygue, reported his experiments with small retaining walls. These experiments revealed that behind a vertical wall holding back a granular material, there was a so-called plane-of-rupture with an angle about midway between angle-of-repose and the vertical. It was down this plane that the material would slide as the retaining wall was tilted, or was moved away (see Fig. 1). The principle involved is that of Coulomb's "Wedge of Maximum Thrust." It has always seemed to me that it was this principle which governed the retention of non-caking material on the slopes of self-cleaning conical and pyramidal bottoms of tanks and bins.

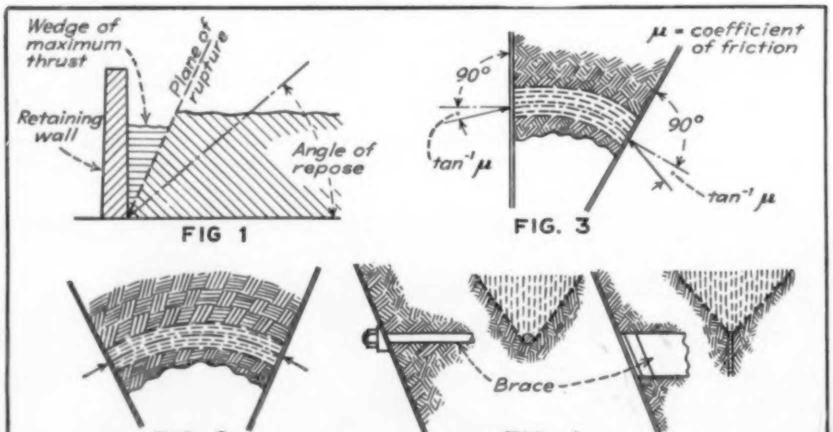
Prof. William Cain in "Earth Pressure, Retaining Walls and Bins," (John Wiley, 1916) has given a solution for this angle but it is sufficient for our purpose to mention that in any practical hopper, material outside a fairly well defined (inverted) cone is actually the last to flow out. Looking at it from this standpoint, the chief advantage of a steeper bottom is that the self-cleaning characteristic comes into action more often, as there is less of the capacity above the cone. This feature is most valuable with materials which cake or pack increasingly with standing.

It has been my contention that so far as concentric, or eccentric, flow is concerned, a more important point is to get valleys steep enough so that they are really self-cleaning. The evidence seems to be conflicting on this point. Good designers on foundry-sand installations usually see that two adjacent sides of each hopper are vertical and that they get good results. On the other hand these good designers watch so many of the other features that the job would probably work well any way.

What About Vertical Walls?

There is a seeming fallacy in argument favoring at least one vertical side. Would two hoppers with one vertical side each, flow better than one hopper made by combining the two? Before you too confidently say "Yes," let me point out that a partition over the discharge gate of a symmetrical hopper would divide it into two hoppers which should then, merely because of the ver-

Retaining-wall analogy affecting flow of material in bins and hoppers; demonstration of arching principles involved; and effect of superposed material on tie rods in hoppers



tical plate, flow more readily. I do not think this would follow. It has been assumed that an arch could not "spring" against a smooth vertical wall. Such an assumption crops up continually but is not in accordance with theory.

When an imperfectly granular material bridges over, cohesion always enters into the picture. The lower surface may be very irregular but only a short distance above there exists an "arch" in the material, sprung between two supporting surfaces. Material is supported on the arch and material clings to its lower side, as in Fig. 2. This arch is not a definite one, but consists merely of a continuous system of pressure forces for which a resultant may be conceived as curving from one support to the other. Theory tells us merely that this resultant must intersect a smooth vertical surface at an angle from the horizontal whose tangent is not greater than the coefficient of friction of material on the wall (see Fig. 3). From this I conclude that a partition plate over the center of the discharge would merely divide the one arch into two arches of half the size and, if anything, slightly impede the flow; and furthermore, that as compared with a hopper having one vertical side, a symmetrical hopper of the same included angle should flow equally as well.

Incidentally, the theory of deep-bin design rests squarely on the analysis of arch action of granular materials against vertical walls.

Air Versus Stirrers

The only experience I have had with stirrers has been uniformly bad. In one case material was to flow intermittently but the stirrer ran continuously and compacted the material. Hence, I would never use stirrers; but if employed, they certainly should only run while the gate is open. Compressed air, to my knowledge, works especially well on dry material which flows freely after starting but which packs upon standing.

I would like to say a word about bracing. If internal braces are necessary, they should be designed not merely as tension members, but as beams carrying a wedge shaped load of material as in Fig. 4. I have seen tension bracing stretched and sagging from this load. In one case of a large brick-walled hopper holding "hogged" refuse from a saw mill, the tie-rods had been too heavy to stretch but had pulled right through the walls.

The importance has been stressed of using the proper valley angle. I think it is even more important to have discharge gates large enough and of proper design. It should be possible to open them easily, wide enough to start the material flowing; and to close them quickly to the proper point for controlling flow. It goes without saying they should close tightly.

Chesman A. Lee
Engineer
Darling & Co.
Chicago, Ill.

Chemical Engineer's BOOKSHELF

New Titles, Editions and Authors

LUBRICANTS AND LUBRICATION. By *James I. Clower*, Published by McGraw-Hill Book Co., New York, N. Y. 464 pages. Price $5.

Reviewed by *M. E. Clark*

FOR MANY YEARS there has been a need for a complete and authoritative book dealing with plant lubrication. Many books have been written about parts of this subject, few have covered more than a single phase of it. Theory, lubricating devices, sources of lubricant, and lubrication tests are some of these phases. Because of the multiplicity of information available from oil companies, it was inevitable that all phases of this broad subject must and would eventually be boiled down to a single volume.

"Lubricants and Lubrication" is such a book. It must have required a great amount of effort. It necessarily was the work of a lubrication expert. Professor Clower was admirably fitted to do this job for several reasons. He was a former oil man himself with one of the large companies. He now conducts one of the few college lubrication laboratories, at V.P.I. Therefore, he has both the practical and academic viewpoint. Both are reflected in his book. Furthermore, Professor Clower, being independent of the oil companies, was free to solicit aid from all of them as well as call upon such authorities as the editors of *Power* and independent lubrication experts. For many years a writer on lubricants and lubricating problems, Professor Clower has an inate ability to express his ideas clearly and concisely.

As to the book itself, it contains eleven chapters devoted to fundamentals of lubrication which apply regardless of industrial use. There is a discussion of source, production, refining and theory of lubrication as well as lubricating appliances and oil-purification methods. Then there are six chapters which cover in detail lubrication of steam turbines, steam engines, air compressors, refrigerating machines and all types of internal combustion engines. The last chapter deals with storing and handling of lubricants.

Not only it the book practical and useful to any plant engineer concerned with lubrication, but it is arranged for academic use as well. The lubrication engineers of tomorrow will not have to ferret out the required background knowledge by dint of much labor and experience as those of today did. They can find much of it here in a single volume.

Chemical engineers will find this book rich in information and highly practical even though it contains little information on the specialized lubricating problems of chemical industry.

ENGINEERING MATERIALS. By *Alfred H. White*. Published by McGraw-Hill Publishing Co., New York, N. Y., 547 pages. Price $4.50.

Reviewed by *Lincoln T. Work*

THIS SUBJECT comprising primarily structural materials but including other major engineering materials is treated from both physical and chemical viewpoints. Methods of processing as well as structural characteristics and behavior in service are presented. Eleven of the twenty-four chapters are devoted to manufacture, fabrication, and properties of iron and ferrous alloys. Other metals considered include copper, nickel, zinc, tin, aluminum, magnesium, lead and their alloys. A chapter is devoted to corrosion of metals and protection by metallic coatings. Four chapters are given to rocks, clay products, fused silicates, glass, slags, refractories, lime, gypsum, and magnesium oxychloride products and the silicate cements. Two chapters are allotted to organic preservative materials, protective coatings, plastics and related products. Fuels and combustion and water and its industrial utilization are each given a chapter.

The work is extensively illustrated with photographs and curves and a short list of selected references is given with each subject. The book is written in an interesting and instructive style. That the non-metallic materials are not treated more exhaustively, that quantitative information on corrosion is scant, and that economic considerations are not developed may well be attributed to the paucity of such information in the literature and the difficulty of presenting available data of this type in a condensed form which will not be misconstrued. Practicing engineers will find this work instructive and it will fill a great need in the educational field.

FARMWARD MARCH. By *William J. Hale*. Published by Coward-McCann, Inc. New York, N. Y., 222 pages.

Reviewed by *Roland P. Soule*

FARMWARD MARCH is the second book written by Dr. William J. Hale since his "The Farm Chemurgic" appeared in 1934, and was distributed widely by the Chemical Foundation. The present volume represents a further stage in the evolution of "chemurgy" as a suggested means of solving both the unemployment and the farm problems. As now depicted, it is presented almost as a religion, with Dr. Hale in the capacity of high priest and chief protagonist.

Nothing particularly new is here added to the basic tenets of chemurgic faith, as defined by the author in his previous writings. The Chemical Revolution, which was climaxed in 1913 by the development of the Haber-Bosch process ("the greatest invention of all time") struck directly at labor on the farm. It has accelerated the shift from agricultural to mineral sources of industrial raw materials. "Under present-day intensive cultivation one farmer in every five can abundantly supply all the wants of our citizens in the matter of food and raiment. What will become of the remaining four out of five farmers in the problem of the hour?"

Whether the number of farmers threatened is four out of five or some smaller proportion, nobody can quarrel with Dr. Hale over the existence of a real farm problem in this country. Also, it is easy to understand his disgust over governmental emphasis on palliatives such as the restriction of plantings, the imposition of processing taxes, and the subsidizing of exports, while comparatively little was done that promised an economically sound long-range solution. And finally, one can agree wholeheartedly with him when he states that "foremost among the requisites for a sound capitalism is the absolute necessity to create new industries and products at a rate sufficient to take up every trace of unemployment likely to arise through improvement in machinery and production." To the extent that these new industries can economically be built upon agricultural products, we shall certainly be closer to the desirable goal of "farm and factory in balance."

Dr. Hale carries far less conviction, however, when he ceases talking objectives and begins talking means. For this purpose he has adopted a rather mystical style in which, among other figures of speech, nature is pictured as "a modern scientific D'Artagnan accompanied by three musketeers." Aramis is cellulose, for which the author sees an annual consumption in the United States of more than 40,000,000 tons by 1965. This would be in the form of 25,000,000 tons of paper, 5,000,000 tons of plastics ("we may confidently await the discarding of

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FIG. 1375
POWELL PAT. RENEWABLE SEAT
WHITE
200 WSP
FIG. 1708
POWELL PATENT
200 WHITE WSP
RENEWABLE SEAT
FIG. 99
POWELL VALVES
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hardwood from the building trade"), 1,000,000 tons of rayon and acetate fiber, and 10,000,000 tons of cellulose derivatives, of which the most important may be ethyl cellulose. "Our gardens, trees, and numerous patches will be covered with transparent canopies (celloveil) and our farmers assured of bountiful crops no matter what the vagaries of weather." Athos is vegetable oil, and the 1965 consumption is estimated at 10,000,000 tons, apparently to be derived chiefly from the soy and castor beans. Soy bean oil is envisaged as a source of plastics ("they are now in commercial production, and supply valuable parts of the Ford automobile"), while castor oil will be used not only for automotive lubrication but as a source of adipic acid for nylon manufacture.

It is Porthos, however, who is dearest to Dr. Hale's heart, and who commands the larger portion of his book. Porthos is alcohol ("agricrude" alcohol of "agrol"), and it will require 250,000,000 acres to produce our annual requirements of 60,000,000,000 gallons, whereas Aramis and Athos can only contribute about 30,000,000 acres each. The alcohol market will be divided a third for road transportation, a third for utilities and railroads, and a third for the manufacture of metaldehyde ("an excellent household fuel"), ethyl cellulose, and "Buna" rubber. In road transportation the initial outlet will be a 10 per cent blend with gasoline, but ultimately there will be distributed a 50 per cent blend with water for use in super high-compression motors.

Writing, as he has done, after the Atchison Agrol Company ceased operations at the end of 1938, Dr. Hale is confronted by the necessity of explaining to his readers why this first practical experiment in applied chemurgics was seemingly a failure. "To combat the seditious influence of international banking interests against agrol, it became necessary for the Atchison plant to dispatch emissaries of goodwill with the sole aim of winning back clients poisoned by iniquitous harangue emanating from all petoleumdom. Though the motives were laudable, the expenses incurred drove up the cost of distribution of agrol to as much as 6 to 8 cents per gallon. With a selling price of 25 cents a gallon, it was not long till outgo topped income, and the plant was forced to close." However, consolation is drawn from the fact that Galileo, Westinghouse, and Morse all had their difficulties with a skeptical age.

Throughout his book Dr. Hale has expressed himself with the extravagant language and almost fanatical zeal of a reformer. His arguments are strictly ex parte. Short shrift is given those who, however sympathetic they may be with the laudable aim of developing industrial markets for farm products, still entertain reservations based on orthodox economics. The reader is called upon either to accept an immediate and sweeping program of chemurgy as a matter of almost religious faith or to be relegated to the ranks of the "international bankers," the "economic sooth-

sayers," and the "Beelzeboobs." There is apparently no room for more plodding intellects, or for the unromantic and prosaic approach recently adopted by the U. S. Department of Agriculture in the establishment of the four regional research laboratories to develop new non-food uses for agricultural surpluses. "We need a Hercules to clean out the Augean stables of Washington."

Dr. Hale's impatience with delay and intolerance for conflicting viewpoints lead him into several extreme positions. He unreservedly endorses autarchy; he condemns international trade; he acclaims the accomplishments of Germany, Italy and Japan. He condones the invasion of Czechoslovakia. "Der Fuhrer, Adolph Hitler, merits unstinted praise for what he has been able to accomplish for Greater Germany in the face of vicious and contemptuous criticism from without." He admires the ability of authoritarian governments to get action. He appears oblivious, however, of the inevitable effect of uneconomic autarchy and unrestrained chemurgy in lowering rather than raising a country's standard of living, even though the adoption of less efficient processes may by their very inefficiency temporarily increase employment.

It is to be doubted that the cause of chemurgy has been greatly advanced by this intemperate polemic.

QUALITATIVE ANALYSIS BY SPOT TESTS. By *Fritz Feigl*. Published by Nordemann Publishing Co., Inc., New York, N. Y. 462 pages. Price $7.

SPOT TESTS are becoming increasingly important both in control laboratories where they save time and in schools where they are economical of materials. This second edition is a translation of the new third German edition, and numerous corrections and new results have been added. Main divisions of the book include tests for metals, tests for acids, systematic analysis of mixtures, organic spot tests, applications of spot reactions and tabular summary of sensitivities. From acetaldehyde to zymase, spot tests are given for the identification of hundreds of organic and inorganic compounds. British spelling was used by the translator and it may prove disconcerting for those unfamiliar with it to read such words as "shewn" and "colour". This, however, is a minor point and the book should fill an important place in many laboratories.

THE MICROSCOPE. By *R. M. Allen*, D. Van Nostrand Company, New York, N. Y., 286 pages. Price $3.00

Reviewed by *E. Henning*

A READER who is not familiar with microscopical technique will be more than glad to obtain all necessary information from Mr. Allen's book. In plain English, microscopy is explained and various types of instruments and accessories are discussed.

The first two chapters give a historical introduction and the optical

principles of the microscope. The treatment of the physical optics is rather elementary, but this book is meant for the beginner and not for the expert. Chapters three to five explain modern instruments, illumination and testing of microscopic objectives. Chapter six bears the heading "Getting the most out of the microscope"; it makes the reader familiar with the microscopical technique, e.g. refractive index measurements, dark field illumination and polarized light. The last chapter, "Preparation of material for microscopical examination" discusses more practical material, for example glass-ware and equipment, embedding methods, polishing, etching and so forth. There are numerous good examples of photomicrography. Bibliography and glossary conclude the book.

One cannot but admire the excellent sketches and photographs that Mr. Allen uses for illustration and clarification. Students in High School and College and people in industry, whose task it is to test products by means of a microscope, will welcome this clearly written little book.

STATISTICAL THERMODYNAMICS. By *R. H. Fowler* and *E. A. Guggenheim*. The MacMillan Company, New York, N. Y., 693 pages. Price $9.50.

Reviewed by *F. C. Nachod*

THE SECOND EDITION of Dr. Fowler's well known treatise "Statistical Mechanics" (Cambridge, 1936) appears in a new version, rewritten by Drs. Fowler and Guggenheim. If a test on thermodynamics usually interprets the experimental data by theory in an *a posteriori* approach, a text on statistical thermodynamics reverses the procedure, i.e. predicts *a priori* the experiment. As the authors state, this book is "the first extensive exposition of all available *a priori* evaluation of thermodynamical functions, although their employment has become increasingly frequent and successful."

The first seven chapters on the fundamental assumptions of statistical mechanics, the general theorems for assemblies of permanent systems, permanent perfect gases, crystals, chemical equilibria and evaporation, Nernst's theorem, grand partition functions, their applications and imperfect gases do not differ very much from chapter I to IX in Fowler's book. However new quotations are used and the mathematical derivations are somewhat easier and less specialized. Chapters VIII to XI on liquids and solutions of non-electrolytes, solutions of electrolytes, surface layers and elementary theory of metals bring for the most part new material. Chapter XII on chemical kinetics bears some similarity with the corresponding one in Fowler's text. However, the reader finds new parts in the hydrogen deuterium reactions and Ramsperger's analysis of data for unimolecular reactions. Finally chapter XIII on lattice imperfection, order-disorder in crystals is new, the last chapter on electric and magnetic properties resembles again chapter XII

in Fowler's book on electric and magnetic susceptibilities and ferromagnetism.

The authors state in their preface that they "attempted to keep the book up to date by including an account of progress made during the past three years" and that "in using experimental data for comparison with theory they have tried to select the most reliable and accurate data." In many cases they have succeeded in doing so, though in some others it is worth mentioning that some important data have escaped attention.

However, Statistical Thermodynamics is a highly recommendable book. Compared with Fowler's second ediiton it is easier to read and contains a considerable amount of new material. It will not be of great interest to the industrial chemist, but of great help and use for teacher and student.

RECENT BOOKS AND PAMPHLETS

IMPACT CLEANING. By *William A. Rosenberger*. Published by The Penton Publishing Co., Cleveland, Ohio. 466 pages. Price $7.

IT WAS the author's purpose to write a book for the buyer and user of sandblast equipment, not as a handbook, but as a guide which will aid in the intelligent use, sales and design of equipment. There are three main divisions of the text. The first, with 18 chapters, covers nozzle blast cleaning equipment; the second, 21 chapters, discusses mechanical impact cleaning; the third, with five chapters, is devoted to the problems of ventilation. There are 255 line drawings which amplify the text. An interesting commentary on the thoroughness with which the author has done his job is the fact that the appendix includes an 11 page glossary of foreign terms.

OUR WORLD TRADE, January-September, 1939. Compiled and published by Foreign Commerce Department, Chamber of Commerce of the United States, Washington, D. C.

GIVES VALUE and volume of principal exports and imports between United States and chief foreign markets during first 9 months of 1939. The annual report bearing the same title will be issued later.

REFINING PRECIOUS METAL WASTES. By *C. M. Hoke*. Published by Metallurgical Publishing Co., New York, N. Y., 362 pages. Price $5.

ALTHOUGH IT was written for jewelers, dentists, photographers and others to whom metal recovery from filings, clippings, scraps and solutions may be important, this book contains much material of interest to all connected with the precious metals industries. The author has had much experience in this line which permits her to discuss the problems authoritatively. While giving directions and

explanations, she has not lost sight of the economic aspects. The beginner will learn which metals he may refine profitably and which he should throw away. The latter part of the book is for the experienced worker and concludes with discussions of the large professional refineries. An appendix lists laws and regulations, dealers and further sources of information.

WHERE TO FIND THE NEW TRADE NAMES. Compiled by *Alice M. Amoss*, Librarian, Edgewood Arsenal, Md. 32 pages. Price $0.75.

WIDESPREAD USE of trade names in current literature often presents a problem to both research men and purchasing agents. Many products are discussed and sold under brand or trade names which give no indication of their composition or characteristics. It is often necessary to know where to find information as to properties of a product, uses, and source from where it was obtained. It was to fill this need that this booklet was compiled. Under more than 100 headings are published sources of information together with a brief note as to what subjects are covered by the reference.

EVALUATION OF PETROLEUM PRODUCTS. Published by the American Society for Testing Materials, Philadelphia, Pa. 52 pages. Price $0.75.

THE SUBTITLE of this publication—"A Resume of Present Information"—indicates its contents. The six papers, covering the testing of oils, gasoline, greases and fuel oils, review the present status of the testing of petroleum products and lubricants. Each paper includes a number of detailed references which add to the value of the booklet.

LIST OF INSPECTED FIRE PROTECTION EQUIPMENT AND MATERIALS. Published by Underwriters' Laboratories, Inc., Boston, Mass. 151 pages. Price $0.75.

A LIST, revised semiannually, of products which comply with the requirements of the Underwriters' Laboratories, Inc. The appliances and materials have been examined with reference to fire protective capabilities, and to such fire hazards and accident hazards as they are involved in the various groups in which they are listed.

M.K.S. UNITS & DIMENSIONS. By *G. E. M. Jauncey & A. S. Langsdorf*. Published by The Macmillan Co., New York, N. Y. 62 pages. Price $1.

IN THE TITLE of this little book the cryptic initials stand for Meter, Kilogram and Second. These basic units were adopted by The International Electrotechnical Commission in June 1935, the action becoming effective in January 1940. Properties of the new system are described as well as methods for changing from one set of basic units to another. Also a proposed M. K. O. S. system is described in which the ohm is the fourth basic unit.

Government PUBLICATIONS

Documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated, pamphlet is free and should be ordered from bureau responsible for its issue.

Industrial Research and Changing Technology, by George Perazich and Philip M. Field. Works Progress Administration, National Research Project Report No. M-4; mimeographed. Available only from Works Progress Administration, 1734 New York Avenue, Washington, D. C.

Twenty-fifth Annual Report of the National Advisory Committee for Aeronautics, 1939. Includes summary, but not details, of numerous technical reports on aircraft materials; 20 cents.

Comparative Chemical Composition of Juices of Different Varieties of Louisiana Sugarcane, by C. A. Fort and Nelson McKaig, Jr. U. S. Department of Agriculture, Technical Bulletin No. 688; 10 cents.

Report of the Chief of the Bureau of Agricultural Chemistry and Engineering, 1939. U. S. Department of Agriculture; 15 cents.

List of Bulletins of the Agricultural Experiment Stations for the Calendar Years 1937 and 1938, by Catherine E. Pennington. U. S. Department of Agriculture, Miscellaneous Publication No. 362; 15 cents.

Annual Report on Tobacco Statistics, 1939. U. S. Department of Agriculture, Agricultural Marketing Service; mimeographed.

Losses Occasioned by Insects, Mites, and Ticks in the United States, by J. A. Hyslop. U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine, E-444; mimeographed.

Screen Analysis as an Aid in Pulp Evaluation, by E. R. Schafer. U. S. Department of Agriculture, Forest Products Laboratory, Madison, Wis.; mimeographed. (Available only from Forest Products Laboratory, Madison, Wis.)

Census of Forest Products: 1938. Statistics giving paper and paperboard production and paper-making machines in use and pulpwood consumption and wood-pulp production are given in a release of November 1939. Bureau of the Census; mimeographed.

Sugar: Retail Prices in 38 Countries, by Albert S. Nemir. Bureau of Foreign and Domestic Commerce, Foodstuffs Division; mimeographed. Available only from Bureau of Foreign and Domestic Commerce at 10 cents per copy.

Folding Paper Boxes, An Aid to Profitable Packaging, by James D. Studley. Bureau of Foreign and Domestic Commerce, Trade Promotion Series No. 205; 15 cents.

Paper Cones and Tubes (For Textile Winding). National Bureau of Standards, Simplified Practice Recommendation R143-39; 5 cents.

List of Simplified Practice Recommendations. National Bureau of Standards, Letter Circular 582; mimeographed.

Color of Illuminant and Efficiency of the Worker. National Bureau of Standards, Letter Circular 581; mimeographed.

Stability of Sheathing Papers as Determined by Accelerated Aging, by Samuel G. Weissberg, Daniel A. Jessup, and Charles G. Weber. National Bureau of Standards, BMS Report 35; 10 cents.

Survey of American Listed Corporations—Volume I. This volume gives information on 9 manufacturing groups as compiled from reports for fiscal period ending June 30, 1939 filed with Securities & Exchange Commission. These groups include agricultural machinery, automobiles, chemicals and fertilizers, cigarettes, metal and glass containers, meat packing, office machinery, steel, tires and other rubber products. Available for limited distribution only from Securities & Exchange Commission, Washington, D. C.

Effect of Heating and Cooling on the Permeability of Masonry Walls, by Cyrus C. Fishburn and Perry H. Petersen. National Bureau of Standards, BMS Report 41; 10 cents.

Performance Test of Floor Coverings for Use in Low-Cost Housing: Part 1, by Percy A. Sigler and Elmer A. Koerner. National Bureau of Standards, BMS Report 34; 10 cents.

Tabulated Analyses of Texas Crude Oils, by A. J. Kraemer and Gustav Wade. Bureau of Mines, Technical Paper 607; 15 cents.

Review of the Literature on the Construction, Testing, and Operation of Laboratory Fractionating Columns, by C. C. Ward. Bureau of Mines, Technical Paper 600; 10 cents.

Procedure for Applying for Tests Made on All Explosives and Blasting Devices by the Explosives Division of the Bureau of Mines. Bureau of Mines, Schedule 1C; 5 cents.

Survey of Crude Oils of the Producing Fields of Arkansas, by O. C. Blade and George C. Branner. Bureau of Mines, Report of Investigations 3486; mimeographed.

Tests of the Effect of Acid Mine Waters on Various Cements, by R. D. Leitch and J. G. Calverley. Bureau of Mines, Report of Investigations 3487; mimeographed.

Ore-Testing Studies, 1938-39 (Primarily Ore-Dressing). Progress Report 36—Metallurgical Division, by A. L. Engel and S. M. Shelton. Bureau of Mines, Report of Investigations 3484; mimeographed.

Use of Respiratory Protective Devices Under Abnormal Air Pressure, by F. E. Griffith and H. H. Schrenk. Bureau of Mines, Report of Investigations 3488; mimeographed.

Reconnaissance of Mining Districts in Churchill County, Nev., by William O. Vanderburg. Bureau of Mines, Information Circular 7093; mimeographed.

Labor and the Shut-Down of the Amoskeag Textile Mills, by Daniel Creamer and Charles W. Coulter. Works Progress Administration, National Research Project Report No. L-5. Available from Works Progress Administration, 1734 New York Avenue, N. W., Washington, D. C.

Consumer Expenditures in the United States, Estimates for 1935-36. National Resources Committee; 50 cents.

Progress Report, National Resources Committee, Fiscal Year Ending June 30, 1939; 35 cents.

Toxicity of Certain Organic Insecticides to Codling Moth Larvae in Laboratory Tests, by E. H. Siegler, F. Munger, and L. E. Smith. U. S. Department of Agriculture, Circular No. 523; 5 cents.

—Manufacturers' LATEST PUBLICATIONS

Alloys. Driver-Harris Co., Harrison, N. J.—Data book R-40—56 pages on electric heat- and corrosion-resisting alloys, with resistance tables, information on life expectancy at various temperatures, information on electric furnace design, prices, properties and other tabulated information.

Alloys. Monsanto Chemical Co., St. Louis, Mo.—Bulletin No. 2—62-page report on phosphorus iron alloys, published by the Phosphate Division of this company. Deals with an experimental research investigation into the corrosion and mechanical influences of various alloying elements in low-alloy steels containing phosphorus.

Apparatus. Bausch & Lomb Optical Co., Rochester, N. Y.—8-page reprint of an article by Haller Belt describing the use of the polarizing microscope in crystal analysis.

Apparatus. Harry W. Dietert Co., 9330 Roselawn Ave., Detroit, Mich.—4-page leaflet on this company's "Moisture Teller," a device made in various models for the rapid determination of moisture in chemicals, rubber, pulp, sugar, etc.

Apparatus. Puritan Compressed Gas Corp., Kansas City, Mo.—Catalog 27—12-page folder on this company's equipment and compressed gases for gas therapy.

Autoclaves. Struthers-Wells, Titusville, Pa.—8-page catalog describing construction and advantages of this company's line of quick-opening autoclaves made in capacities from ½ to 2,000 gal. capacity, for pressures up to 25,000 lb. per sq. in.

Bearings. Johnson Bronze Co., New Castle, Pa.—Catalog L-2—22-page stock and price list on this company's self-lubricating bronze bearings.

Bearings. New Departure Div., General Motors Sales Corp., Bristol, Conn.—Booklet R-27—1940 edition of this company's Ball Bearing Interchangeability Tables in booklet form.

Building Materials. The Philip Carey Co., Lockland, Cincinnati, Ohio—12-page book on this company's building materials and insulations. Includes heat insulations from sub-zero to 2,500 deg. F., air-conditioning ducts and insulation, corrugated roofing and siding materials, roof coatings, floorings and similar materials.

Chemicals. Casein Co. of America, 350 Madison Ave., New York, N. Y.—48-page book on Protovac modified caseins and caseinates with information on chemical and physical properties of various types, and suggested uses. Covers 12 types plus plasticizers and defoamers.

Chemicals. Pennsylvania Salt Mfg. Co., Philadelphia, Pa.—Wall chart, size 19½x14 in., covering safety recommendations in the use and handling of chlorine.

Controls. Bender Warrick Corp., Birmingham, Mich.—Bulletin 40—16 pages on this company's controls, including electric floatless level controls, signal and pump controls, motor starters and relays.

Controls. The Mercoid Corp.—Catalog 400—60-pages on this company's automatic controls for industrial applications and for heating, air conditioning and refrigeration.

Controls. Sarco Co., 183 Madison Ave., New York, N. Y.—Bulletin 197—8 pages on this company's cooling controls and mixing valves for various water and brine control applications.

Copper Paint. Phelps Dodge Refining Corp., 40 Wall St., New York, N. Y.—8-page booklet describing a new series of copper paints made by this company for application to wood, metal and concrete. General utility and three special purpose paints are made of thin copper flakes suspended in appropriate vehicles, for brushing or spraying.

Crushers. Pennsylvania Crusher Co., Liberty Trust Bldg., Philadelphia, Pa.—Bulletin 1030—4 pages with description and engineering data on this company's reversible hammermills.

Electrical Equipment. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Bulletin 6043—4 pages describing this company's transformers equipped with the non-flammable insulating liquid, Chlorextol.

Electrical Equipment. Electric Machinery Mfg. Co., Minneapolis, Minn.—Publication 160—2-page leaflet describing this company's new line of high-speed "packaged" synchronous motors.

Electrical Equipment. Micro Switch Corp., Chicago, Ill.—Data Sheets 8 and 20—4-page leaflets describing various types of Micro switch with price list, operating characteristics and information on various types available.

Electrical Equipment. The Okonite Co., Passaic, N. J.—Bulletins OK2009 and OK2012 — Respectively 16 and 4 pages on new "Okolite-Okoprene" neoprene-insulated cables made by this company for superior resistance to oils, solvents, chemicals and weathering.

Equipment. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—33-page 1940 directory of products and engineering literature of this company, listing more than 350 separate bulletins and other engineering aids now available on request in the field of electrical equipment, process equipment, kilns, disintegration equipment, power plant equipment, pumps, etc. Also Form MS 253, 4 pages describing a new portable engine-driven centrifugal pump available in five sizes from 18 to 110 hp.

Equipment. Falstrom Co., Passaic, N. J.—10-page reprint of an article describing the "streamlining" of the Bristol-Myers drug plant, employing equipment inclosures produced by this company.

Equipment. C. M. Kemp Mfg. Co., 405 East Oliver St., Baltimore, Md.—4-page bulletin describing this company's inert gas producers for chemical and process industries, with description of two types and performance data on various sizes.

Equipment. Worthington Pump & Machinery Corp., Harrison, N. J.—Publications as follows: L-600-B10, 12-page folder describing in detail this company's Type LTC gas-engine driven compressors in sizes from 375 to 1,000 hp.; also Bulletin W-205-B7, 6 pages on this company's two-stage steam-jet ejectors.

Fans. Wagner Electric Corp., 6400 Plymouth Ave., St. Louis, Mo.—Bulletin FU-22—18 pages on this company's air circulating and ventilating equipment, covering industrial, commercial and other types.

Feeders. Hardinge Co., York, Pa.—Form AH-346—Testimonial leaflet concerning this company's constant-weight feeder.

Flaking Mills. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Bulletin 6046—20 pages on heavy duty flaking mills for cereals, brewers' flakes, soybean crushing, etc.

Flotation Reagents. American Cyan-

amid & Chemical Co., 30 Rockefeller Plaza, New York, N. Y.—Book No. 7, Second Edition—29 pages on this company's flotation reagents with detailed information on Aerofloats, xanthates, promoters, frothers, wetting agents and other materials for metallic and nonmetallic flotation.

Gears. Brad Foote Gear Works, 1301 South Cicero Ave., Cicero, Ill.—Catalog 110—246-page book on this company's stock gears, with price list and engineering data on many types; also covers chain, sprockets, pulleys, speed reducers and other power transmission equipment. Also numerous useful information tables.

Grinders. Prater Pulverizer Co., 1801 South 55th Ave., Chicago, Ill.—8-page bulletin describing in detail a new type of grinder for the efficient reduction of dry, light and fibrous materials.

Heat Exchange. The National Radiator Co., Cast Products Div., Johnstown, Pa.—Catalog CP-14—20 pages on cast cooling and condensing sections provided with internal longitudinal ribs and internal swirler fins to promote heat transfer. Four types of section are available.

Heat Transfer. Porcelain Enamel Corp., Cleveland, Ohio—Technical Bulletin 1—28-page reprint of original issue of this bulletin dealing with heat transfer of porcelain enamel, metals and other materials; a report of an investigation conducted in this company's research laboratories.

Heaters. Westinghouse Electric & Mfg. Co., Department 8-N-48, East Pittsburgh, Pa. — Catalog 28-000 — 38 pages on improved electric heating units and controls for industrial application in heating liquids, solids and air.

Hose. Mechanical Goods Division, U. S. Rubber Co., 1790 Broadway, New York, N. Y. — Form M9333 — 34-page book on "Hose Hints," describing types of industrial hose, methods of construction, hose fittings, uses, and types for specific applications. Includes numerous tables of useful information.

Instruments. The Bristol Co., Waterbury, Conn.—Catalog 4050—Bulletin on this company's Free-Vane air-operated control instruments for temperature, pressure, flow, liquid level, draft, humidity and pH. Also Bulletin 542, discussing indicating and recording tachometers.

Instruments. The Philadelphia Thermometer Co., 915 Filbert St., Philadelphia, Pa.—Catalog 104—12 pages on new mercury-to-mercury thermo-regulators and thermostats; also mercury relays supplied by this company.

Lighting. Van Dyke Industries, 2857 South Halsted St., Chicago, Ill.—Folder describing a variety of fluorescent lamp units produced by this company for drafting and industrial work and for desk lighting.

Materials Handling. Link-Belt Co., 307 North Michigan Ave., Chicago, Ill. —Book No. 1700—48 pages on this company's conveying equipment in American industry, devoted largely to a pictorial representation of numerous industrial applications of this equipment. Also Folder 1804, 4 pages on acid-resistant bronze drive and conveyor chains.

Packaging. The Triangle Package Machinery Co., 906 North Spaulding Ave., Chicago, Ill.—16-page booklet giving facts and figures in a variety of cases where packaging was accomplished with this company's machinery.

Packing. The France Packing Co., Tacony, Philadelphia, Pa.—Catalog M —44 pages on this company's metal packings for oil, gas, refrigeration and other uses, for piston rods, valve stems, etc.

Partitions. Johns-Manville, 22 East 40th St., New York, N. Y. — Form TR22-A—20 pages on this company's Transite movable asbestos walls for factories, offices, etc.

Power Transmission. Alexander Bros., Inc., 406 North 3d St., Philadelphia, Pa. —Form A-13—8 pages describing a new duplex leather link belt, developed by

this company for slow, heavy-pull drives where some slippage is required.

Power Transmission. D. O. James Mfg. Co., 1114 West Monroe St., Chicago, Ill.—4-page leaflet describing advantages of, and listing prices and engineering data on, this company's flexible couplings.

Power Transmission. The Jeffrey Mfg. Co., Columbus, Ohio—Catalog 725—84 pages on this company's drive chain for every type of service with description, engineering data and typical applications. Gives design information and other useful data.

Power Transmission. Morse Chain Co., Ithaca, N. Y.—Bulletin R-54—24 pages on this company's roller chains, with particular emphasis on roller chain engineering data and drive design.

Power Transmission. The Speedmaster Co., Des Plaines, Ill.—4-page leaflet describing this company's variable speed pulleys for infinitely variable speed changing in V-belt driven equipment.

Pumps. Fairbanks, Morse & Co., 600 South Michigan Ave., Chicago, Ill.—Bulletin 5810D—24-page book on single-stage centrifugal pumps with information on design and construction and tables on pump selection and hydraulic data.

Pumps. Morris Machine Works, Baldwinville, N. Y.—Bulletin 176—4 pages on this company's Type ST-P centrifugal paper stock pumps. Explains distinctive design features.

Pumps. Quimby Pump Co., 340 Thomas St., Newark, N. J.—Bulletin R-400—8 pages with description and engineering data on this company's new line of pulsationless helical-gear rotary pumps in sizes from 1 to 6 in.

Resistant Paints. Socony Paint Products Co., 26 Broadway, New York, N. Y.—14-page technical booklet on Sovaklor chemical resistant paints, describing their recommended use for general factory maintenance work in areas where chemical conditions are unusually severe. This product is described as highly resistant to all alkalis and practically all acids.

Safety. Mine Safety Appliances Co., Pittsburgh, Pa. — Bulletin CK-1 — Describes safety insoles for work shoes, made of overlapping spring steel strips designed for flexibility while eliminating sole punctures.

Shipments. Acme Steel Co., 2840 Archer Ave., Chicago, Ill.—Form AD14—4-page folder describing this company's steel strapping equipment and illustrating numerous typical packages produced through its use.

Superheaters. Combustion Engineering Co., 200 Madison Ave., New York, N. Y. — Bulletin P-188 — 24 pages on Elesco superheaters with numerous diagrams showing various arrangements for applications in different types of boilers.

Tools. The Garlock Packing Co., Palmyra, N. Y.—Form AD-129—4-page folder describing a new flange-jack made by this company for simplifying the prying apart of flanges for the replacement of gaskets.

Valves. Consolidated Safety Valve Div., Manning, Maxwell, & Moore, Inc., Bridgeport, Conn. — Catalog 1600 — 90 pages on gas and oil relief valves, with capacity tables, over-pressure factor curves and valve selection data.

Valves. The Lunkenheimer Co., P. O. Box 360 Annex Station, Cincinnati, Ohio—Circular 504 RL—8 pages on this company's "King-Clip" gate valves, with information on types, construction details, dimensions and list prices of valves, trimmed appropriately for various types of service.

Washrooms. Scott Paper Co., Chester, Pa.—10-page booklet on advantages in the use of paper towels in industrial washrooms, with discussion of proper placement of washroom fixtures.

Welding. Linde Air Products Co., 30 East 42d St., New York, N. Y.—Form 4464—Chart giving recommended welding methods and other information for the welding of 30 different metals and alloys.


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Chemical ECONOMICS and MARKETS

DROP IN OPERATING RATES REPORTED FOR SOME CHEMICAL CONSUMING INDUSTRIES

WITH revised data at hand for operations in the principal lines which are consumers of chemicals, it is established that January made a splendid showing as far as disappearance of chemical products is concerned. With few exceptions, the rate reached in December was maintained or bettered. Activities in the fertilizer trade which had started earlier than usual and were expected to fall behind the seasonal rise for January, actually represented a rise in output for superphosphate. All branches of glass manufacture reported large outputs including containers. Rayon yarn showed little change from the preceding month but the industry, including the staple branch, entered the year with plant capacities considerably enlarged over that at the beginning of 1939. Textile outputs made appreciable gains over the December figures with cotton mills leading in the increase.

Chem. & Met. Index for Consumption of Chemicals

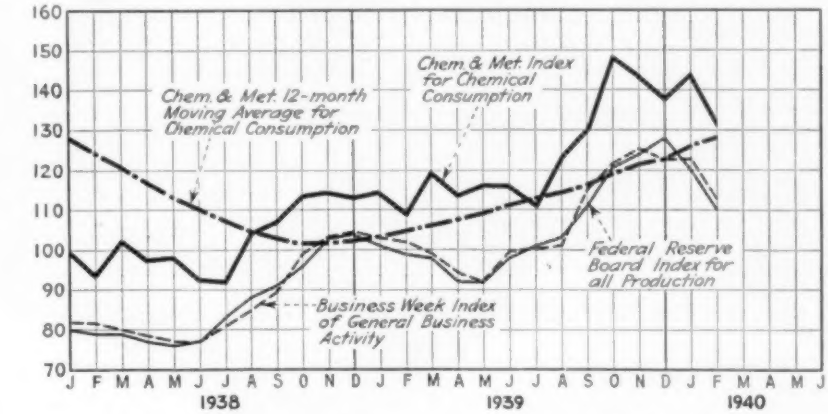
	December revised 1939	January 1940
Fertilizer	32.19	34.23
Pulp and paper	18.19	18.10
Glass	12.30	12.96
Petroleum refining	13.81	14.01
Paint and varnish	8.70	9.31
Iron and steel	11.40	10.97
Rayon	11.10	11.28
Textiles	8.05	9.20
Coal products	9.01	9.01
Leather	3.70	4.10
Explosives	4.45	5.06
Rubber	2.96	3.32
Plastics	2.56	2.60
	138.42	144.15

Steel plants, however, adopted progressively declining operation schedules and this trend carried into the present month. Activities at glass plants slowed up in the latter part of February and in early March. Similar reports came from textile centers and it is evident that some of the large consuming industries have failed to hold the levels reached in January.

From incomplete data the preliminary index for consumption of chemicals in February is placed at approximately 133 which compares with a revised index of 144.15 for January. For 1939 the indexes for January and February were 114.97 and 109.82 respectively. As these indexes are not adjusted according to seasonal influences, the drop in February each year is partly accounted for by the reduction in the number of working days although this year the decline was also the result of a drop in production schedules at some consuming plants.

In view of the high rate of general industrial production in recent months demand for rubber is holding up well, rayon manufacturers have opened their bookings for April deliveries with good results, and export call for chemicals promises to hold well above normal levels.

In the report for sales prepared monthly by the Bureau of the Census in cooperation with the National Association of Credit Men, it was stated that manufacturers' sales of all goods in January were 22.1 per cent above those reported



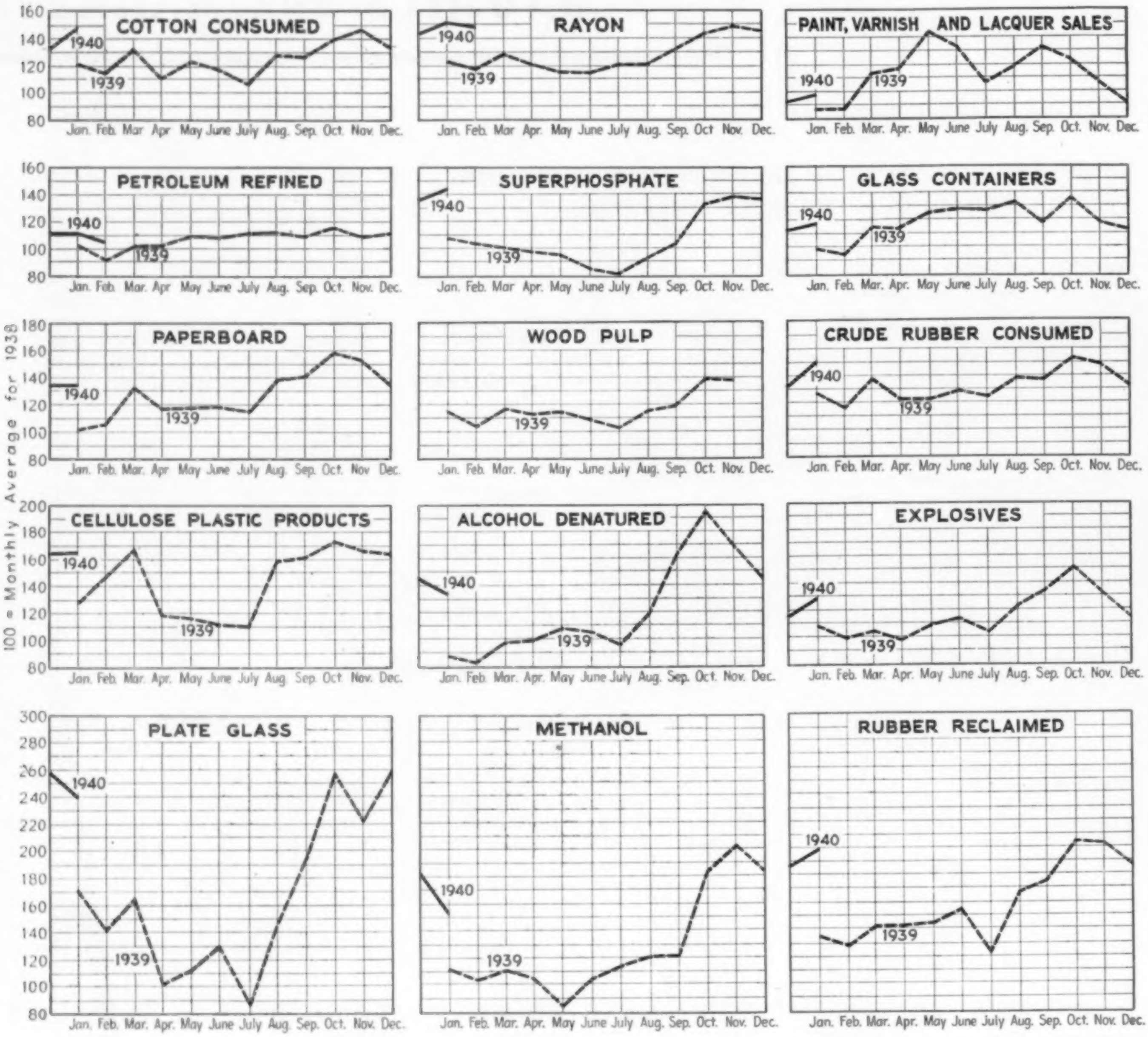
a falling off from peak levels is more or less to be expected but the outlook for the near future has not been changed materially. Seasonal influences already are working in favor of enlarged demand for chemicals. Paint-making materials are beginning to move more freely, tag sales for fertilizer exceed those for last year, automotive outputs are at high levels, for January 1939. For chemicals and related products, the report showed increases of 9.6 per cent over the December figures and 16.9 per cent above the January 1939 total. Percentage changes for January as compared with January 1939 and with December 1939 were given for some of the chemical-consuming trades as follows: paint and varnish, up 13.7.

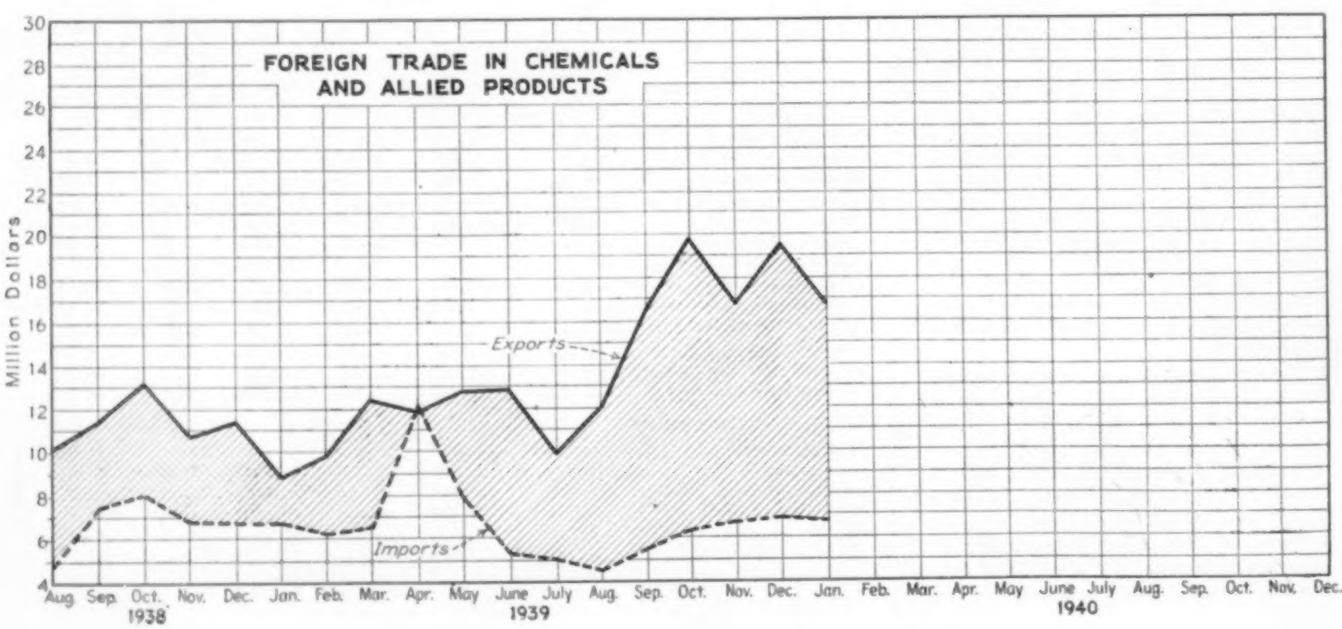
Production and Consumption Data for Chemical-Consuming Industries

Production	Jan. 1940	Jan. 1939	Dec. 1939	Percent of gain Jan. 1940 over Jan. 1939	Percent of gain Jan. 1940 over Dec. 1939
Alcohol, ethyl, 1,000 pr. gal	20,656	17,067	22,080	21.0	6.4*
Alcohol denatured, 1,000 wi. gal	10,398	6,827	11,158	52.3	6.8*
Ammonia liquor, 1,000 lb	4,807	3,932	4,897	22.3	1.8*
Ammonium sulphate, tons	60,393	45,757	60,455	32.0	0.1*
Automobiles, sales, no	432,101	342,168	452,142	26.3	4.4*
Benzol, 1,000 gal	11,424	7,788	11,536	46.7	0.9*
Byproduct coke, 1,000 tons	4,707	3,367	4,718	36.8	0.2*
Glass containers, 1,000 gr	4,263	3,519	4,046	21.1	5.0
Plate glass, 1,000 sq. ft	17,257	12,209	18,477	41.3	6.6*
Window glass, 1,000 boxes	1,413	943	1,189	49.8	18.9
Methanol, synthetic, 1,000 gal	3,453	2,463	4,184	40.2	17.5*
Methanol, crude, 1,000 gal	457	352	434	30.0	5.6
Nitrocellulose plastics, 1,000 lb	1,239	923	1,089	34.2	13.8
Rubber reclaimed, tons	20,400	13,763	19,249	48.9	6.0
Consumption					
Cotton, bales	730,143	598,132	652,695	22.1	11.9
Silk, bales	29,506	40,816	21,128	27.7*	39.6
Wool, 1,000 lb	37,724	35,725	30,043	5.6	25.6
Explosives, 1,000 lb	34,690	29,258	30,580	18.6	13.4
Rubber reclaimed, tons	17,600	13,000	15,575	35.4	13.0
Rubber crude, tons	55,000	46,234	48,143	19.0	14.2
Waste paper, tons	280,333	233,311	283,228	20.2	1.0*

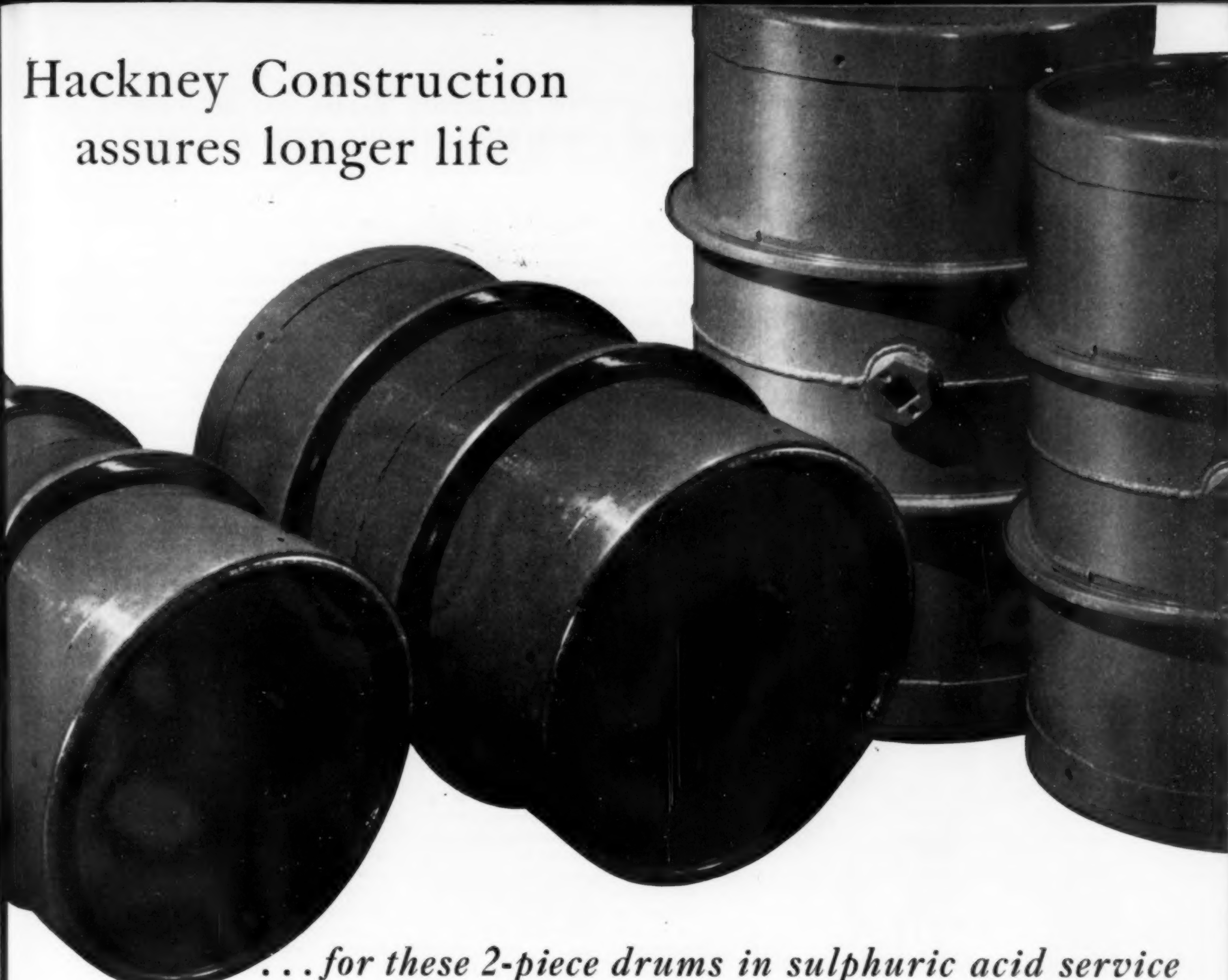
* Per cent of decline.

Production and Consumption Trends





Hackney Construction assures longer life



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The added strength and greater durability of these Hackney drums have been conclusively proved in tests and by records of performance in actual service.

The two-piece construction, eliminating chime crevices, minimizes the possibility of "chime failure." And the reinforced, separate chime protectors as well as the I-bar hoops increase resistance to rough handling and abuse. Two-pass circumferential butt weld, and attachment of heavy forged spuds by two-pass weld, with complete penetration, avoid possibility of crevices and resulting corrosion and bung failures. Durability is still further increased by heat treatment.

Hackney Aqua Ammonia Drums

—are similar in design and construction to the Hackney sulphuric acid drum. Pickled sheets of special analysis steel are used in the fabrication of Hackney ammonia drums to provide for shipment of clean colorless aqua ammonia.

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MOVEMENT OF CHEMICALS FAIRLY STEADY DESPITE SLOWER OPERATIONS AT SOME CONSUMING PLANTS

THE market for chemicals has held a fairly steady course in spite of the fact that some consumers have been operating at a reduced rate. Deliveries against contracts have been going forward in large volume but trading in the spot market has been slower. Some chemicals which are in limited supply still command relatively high prices but there is not so much inquiry for them as was reported a month or two ago. Speculative holdings of certain chemicals are reported to be responsible for the high spot quotations. This has especial reference to chlorate of potash and sesquisulphide of phosphorous which are in demand from match manufacturers. Relief for this situation is expected soon as domestic production is said to be rising and by June is expected to be able to take care of consuming requirements. Incidentally, imports of chlorate and perchlorate of potash in January amounted to 758,364 lb. This is below the average monthly imports last year when 11,955,567 lb. were brought into this country. However, the fact that imports are still moving in such volume combined with the increase in home output augurs well for ample stocks later on.

While the stringency in some of the heavy chemicals which was in evidence in the latter part of last year has been eliminated, the movement from producing plants is said to have kept surplus stocks at relatively low levels. Sulphuric acid has suffered somewhat because of smaller use in the steel trade but demand has continued to remain far ahead of this time last year. Caustic soda and soda ash have been moving freely with the principal consumers operating at a high rate.

Foreign trade in chemicals has assumed more than ordinary importance and promises to remain a factor for some time to come. Exports in January fell below the levels reached in the two preceding months yet was valued at $16,792,512. The increased call from foreign markets has been well distributed over the list. In the coal-tar group, outward shipments have increased for dyes, intermediates, toluol, xylol, and finished products. In the chemical specialty group, unusual call has been felt for such items as nicotine sulphate, copper sulphate, calcium arsenate, petroleum jelly, and textile specialty compounds. Among exports of industrial chemicals, acetic acid, boric acid, methanol, glycerine, acetone, butyl alcohol and acetate, formaldehyde, aluminum sulphate, calcium chloride, and potassium compounds have been prominent.

Exports of sodium compounds in January were reported at 58,612,650 lb. with caustic accounting for 21,151,833 lb. of this total. Other soda compounds which were shipped out in large volume included: borate, 14,382,447 lb., carbonate, 12,417,419 lb., bichromate and chromate, 1,989,681 lb., and phosphate, 551,825 lb. Foreign buying of carbon black also has been on the up grade with January shipments amounting to 20,109,979 lb.

In view of the strong position of salt cake in domestic markets it is interesting to note that imports last year reached a total of 148,795 tons of which 103,260 tons came from Germany. Belgium supplied 25,607 tons, Canada, 9,518 tons, Poland and Danzig, 5,111 tons with the remainder coming from the United Kingdom, Netherlands and Chile. The drop in arrivals from Chile was noteworthy as the totals for 1937 and 1938 were 17,121 tons and 26,079 tons respectively while the 1939 arrivals were only 1,503 tons.

Imports of salt cake in January were 10,457 tons which if maintained would mean something over 120,000 tons for year. While other suppliers may become more active, there will be difficulty in making up for the loss of shipments from Germany.

Price changes during the month included higher sales schedules for lead oxides and tin salts under the influence of the metal markets. Fractional advances also were reported for carbon black for second quarter delivery. Following an announcement that Italy had barred exports of quicksilver for the duration of the war, this material rose in price and was followed by similar action in the market for mercurials and other products which require quicksilver in their manufacture. On the down side, spirits of turpentine was cited as falling from the level quoted a month ago. Casein was lower in the Argentine and domestic markets likewise weakened. Lower figures were named for forward deliveries of calcium arsenate and some of the other agricultural chemicals. The majority of chemicals, however, held a steady price position and apparently the current quotations will be extended for April-June shipments.

A two-way movement was reported in the market for oils and fats. Linseed oil closed at an advance with prospects favoring higher costs for Argentine seed. Estimates on the Argentine acreage have been reduced and now indicate a drop of about 10 per cent from the 1939

CHEM. & MET.

Weighted Index of

CHEMICAL PRICES

Base = 100 for 1937

This month	**98.84**
Last month	98.96
March, 1939	97.75
March, 1938	100.43

Some of the metal salts were moved up in price and some of the agricultural chemicals were reduced. Turpentine eased off in late trading. The majority of heavy chemicals hold a steady price course with no definite tendency toward change.

figure. Ocean freights for moving seed from the Argentine also are higher and the effect of this was seen in higher quotations for oil. Soybean oil has been finding a good export inquiry and prices have stiffened. Palm oil sold more in buyers favor and animal fats held a slightly lower price average.

A report from Canada says announcement has been made by Canadian Industries, Ltd., of the proposed construction during the spring of 1940 of a plant to produce ammonium chloride at Hamilton, Ontario. Canadian Industries produce the necessary raw materials for ammonium chloride. The salt is used chiefly in the manufacture of dry cells, galvanizing, tanning, soldering fluxes and as a source of nitrogen for yeast. Canadian supplies have been received chiefly from Europe.

From Italy it is reported that there are insufficient supplies of coal in Italy to satisfy the current needs for fuel and industrial purposes for curtailed operations in the soda industry. It is said that the soda producers have not enough coal to keep their plants operating at normal rates and it has been necessary to restrict deliveries of caustic soda to viscose plants by 20 per cent and of soda ash to glass factories by as much as 50 per cent. The coal shortage is due to lack of deliveries from Polish mines and a sharp curtailment in shipment from German mines.

Total tax tag sales in February in 17 States, according to reports by control officials to The National Fertilizer Association, amounted to 717,752 equivalent tons. This represented a gain of 4.8 per cent over February 1939 but tonnage was somewhat below the corresponding month of 1938 and 1937. An 8 per cent increase over last year was reported by the South, reflecting larger tonnages in Virginia, the Carolinas, Georgia, Alabama, and Texas, which more than offset declines in the other six States. Missouri was the only one of the five Midwestern States to show an increase over February 1939. The sharpest decline for the month in the area was in Indiana, where January sales had been abnormally large. Aggregate sales in the first two months of the year were 3.6 per cent larger than in the same period of 1939, the result of a small rise in the South and a substantial gain in the Midwest.

CHEM. & MET.

Weighted Index of Prices for

OILS AND FATS

Base = 100 for 1937

This month	**81.53**
Last month	81.40
March, 1939	70.83
March, 1938	80.31

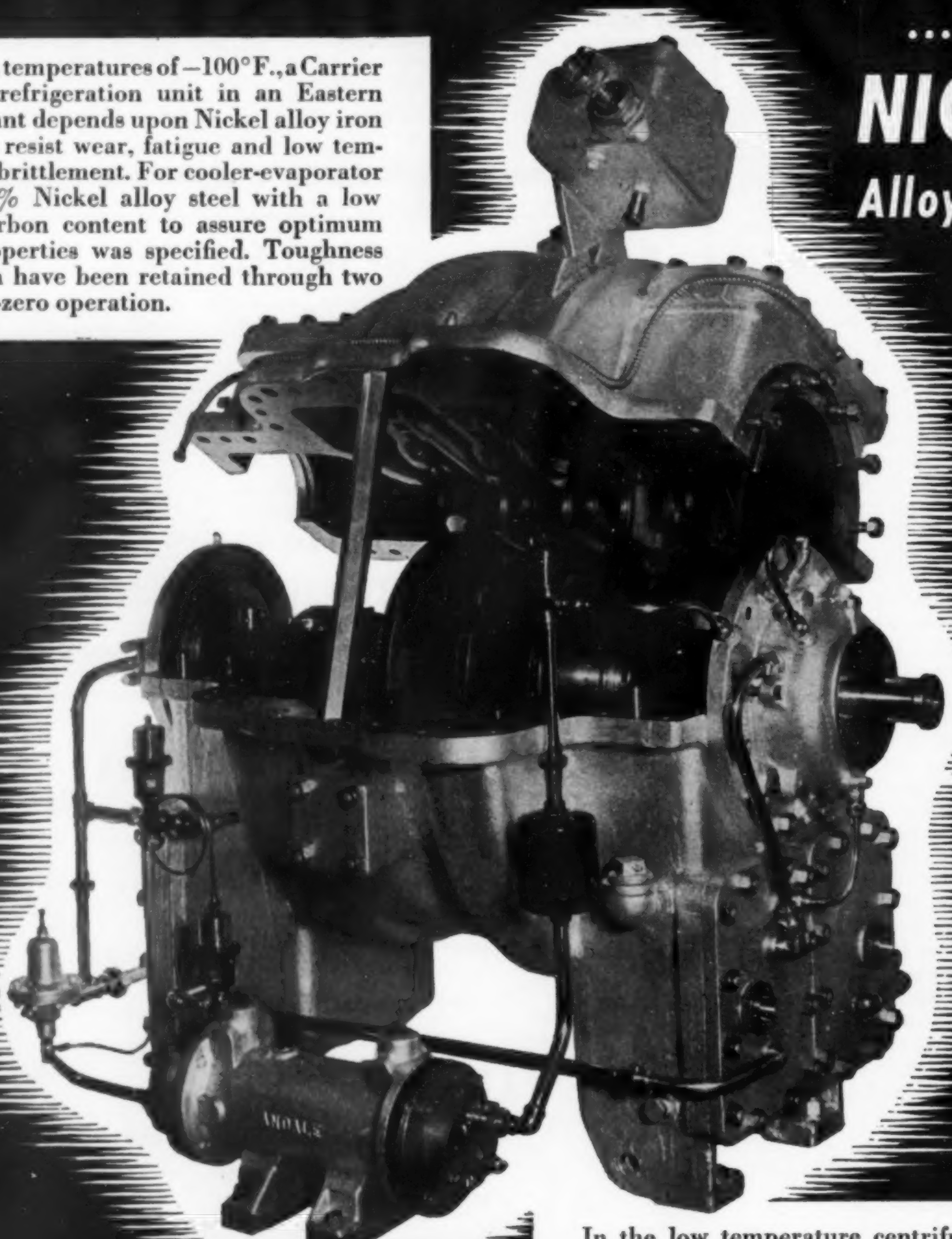
The price movement was mixed last month with a net gain for the index number. Cottonseed oil closed much firmer with linseed and soy oils slightly higher. Animal fats were off somewhat from last months closing prices.

100° below zero F. but

TOUGHNESS RETAINED

...in NICKEL Alloy Steels

Operating at temperatures of −100°F., a Carrier centrifugal refrigeration unit in an Eastern chemical plant depends upon Nickel alloy iron and steel to resist wear, fatigue and low temperature embrittlement. For cooler-evaporator parts a 3½% Nickel alloy steel with a low (0.10%) carbon content to assure optimum welding properties was specified. Toughness and strength have been retained through two years of sub-zero operation.



In the low temperature centrifugal refrigeration compressor pictured above, Carrier Engineering Co., Syracuse, N. Y., specified 3½% Nickel alloy steel, SAE 2335, heat treated to develop higher properties, for shafts and impellers. The compressor casing is a high strength cast iron containing 1% Nickel. When you need materials which retain strength and toughness at sub-zero temperatures, a safe guide is the high impact values inherent in irons and steels containing Nickel.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.

INDUSTRIAL CHEMICALS

	Current Price	Last Month	Last Year
Acetone, drums, lb	$0.07¼–$0.07½	$0.07¼–$0.07½	$0.05¾–$0.06¾
Acid, acetic, 28%, bbl., cwt	2.23 – 2.48	2.23 – 2.48	2.23 – 2.48
Glacial 99%, drums	8.43 – 8.68	8.43 – 8.68	8.43 – 8.68
U. S. P. reagent	10.25 –10.50	10.25 –10.50	10.25 –10.50
Boric, bbl., ton	106.00–111.00	106.00–111.00	106.00–111.00
Citric, kegs, lb	.20 – .23	.20 – .23	.22½– .25
Formic, bbl., ton	.10½– .11	.10½– .11	.10½– .11
Gallic, tech., bbl., lb	.90 – 1.00	.90 – 1.00	.70 – .75
Hydrofluoric 30% carb., lb	.07 – .07½	.07 – .07½	.07 – .07½
Lactic, 44%, tech., light, bbl., lb	.06½– .06¾	.06½– .06¾	.06½– .06¾
Muriatic, 18°, tanks, cwt	1.05 –......	1.05 –......	1.05 –......
Nitric, 36°, carboys, lb	.05 – .05¼	.05 – .05¼	.05 – .05¼
Oleum, tanks, wks., ton	18.50 –20.00	18.50 –......	18.50 –20.00
Oxalic, crystals, bbl., lb	.10¾– .12	.10¾– .12	.10¾– .12
Phosphoric, tech., c'bys., lb	.07½– .08½	.07½– .08½	.07½– .08½
Sulphuric, 60°, tanks, ton	13.00 –......	13.00 –......	13.00 –......
Sulphuric, 66°, tanks, ton	16.50 –......	16.50 –......	16.50 –......
Tannic, tech., bbl., lb	.44 – .45	.40 – .45	.40 – .45
Tartaric, powd., bbl., lb	.37¼–......	.35¼–......	.27¼–......
Tungstic, bbl., lb	nom.	nom.	2.75 –......
Alcohol, amyl	......–......	......–......	......–......
From Pentane, tanks, lb	.101–......	.101–......	.101–......
Alcohol, Butyl, tanks, lb	.09 –......	.09 –......	.08 –......
Alcohol, Ethyl, 190 p'f., bbl., gal	4.54 –......	4.54 –......	4.54 –......
Denatured, 190 proof	......–......	......–......	......–......
No. 1 special, bbl., gal. wks	.29½–......	.29½–......	.28 –......
Alum, ammonia, lump, bbl., lb	.03½– .04	.03½– .04	.03½– .04
Potash, lump, bbl., lb	.03¾– .04	.03¾– .04	.03¾– .04
Aluminum sulphate, com. bags, cwt	1.15 – 1.40	1.15 – 1.40	1.15 – 1.40
Iron free, bg., cwt	1.30 – 1.55	1.30 – 1.55	1.30 – 1.55
Aqua ammonia, 26°, drums, lb	.02¼– .03	.02¼– .03	.02 – .03
tanks, lb	.02 – .02¾	.02 – .02¾	.02 – .02¾
Ammonia, anhydrous, cyl., lb	.16 –......	.16 –......	.15½– .16
tanks, lb	.04½–......	.04½–......	.04½– .16
Ammonium carbonate, powd. tech., casks, lb	.09 – .12	.09 – .12	.08 – .12
Sulphate, wks., cwt	1.40 –......	1.40 –......	1.40 –......
Amylacetate tech., tanks, lb	.11½–......	.11½–......	.09½–......
Antimony Oxide, bbl., lb	nom.	nom.	.11 – .12
Arsenic, white, powd., bbl., lb	.03 – .03½	.03 – .03½	.03 – .03½
Red, powd., kegs, lb	.15¾– .16	.15¾– .16	.15¾– .16
Barium carbonate, bbl., ton	52.50 –57.50	52.50 –57.50	52.50 –57.50
Chloride, bbl., ton	79.00 –81.00	79.00 –81.00	79.00 –81.00
Nitrate, casks, lb	.07 – .08	.07 – .08	.07 – .08
Blanc fixe, dry, bbl., lb	.03½– .04	.03½– .04	.03½– .04
Bleaching powder, f. o. b., wks., drums, cwt	2.00 – 2.10	2.00 – 2.10	2.00 – 2.10
Borax, gran., bags, ton	48.00 –51.00	48.00 –51.00	48.00 –51.00
Bromine, cs., lb	.30 – .32	.30 – .32	.30 – .32
Calcium acetate, bags	1.90 –......	1.90 –......	1.65 – 1.75
Arsenate, dr., lb	.06 – .06¾	.06¾– .07	.06¾– .07
Carbide drums, lb	.04¾– .05	.04¾– .05	.05 – .06
Chloride, fused, dr., del., ton	21.50 –24.50	21.50 –24.50	21.50 –24.50
flake, dr., del., ton	23.00 –25.00	23.00 –25.00	23.00 –25.00
Phosphate, bbl., lb	.07½– .08	.07½– .08	.07½– .08
Carbon bisulphide, drums, lb	.05 – .06	.05 – .06	.05 – .06
Tetrachloride drums, lb	.04¾– .05½	.04¾– .05½	.04¾– .05½
Chlorine, liquid, tanks, wks., lb	1.75 –......	1.75 –......	1.75 –......
Cylinders	.05½– .06	.05½– .06	.05½– .06
Cobalt oxide, cans, lb	1.84 – 1.87	1.84 – 1.87	1.67 – 1.70
Copperas, bgs., f. o. b., wks., ton	17.00 –18.00	17.00 –18.00	15.00 –16.00
Copper carbonate, bbl., lb	.10 – .16½	.10 – .16½	.10 – .16
Sulphate, bbl., cwt	4.60 – 4.85	4.75 – 5.00	4.50 – 4.75
Cream of tartar, bbl., lb	.28¾–......	.28¾–......	.22¾–......
Diethylene glycol, dr., lb	.22 – .23	.22 – .23	.22 – .23
Epsom salt, dom., tech., bbl., cwt	1.80 – 2.00	1.80 – 2.00	1.80 – 2.00
Ethyl acetate, drums, lb	.06½–......	.06½–......	.061–......
Formaldehyde, 40%, bbl., lb	.05¾– .06¼	.05¾– .06¼	.05¾– .06¼
Furfural, tanks, lb	.09 –......	.09 –......	.09 –......
Fusel oil, ref. drums, lb	.16 – .17	.16 – .17	.12½– .14
Glaubers salt, bags, cwt	.95 – 1.00	.95 – 1.00	.95 – 1.00
Glycerine, c.p., drums, extra, lb	.12½–......	.12½–......	.12½–......
Lead:			
White, basic carbonate, dry casks, lb	.07 –......	.07 –......	.07 –......
White, basic sulphate, sck., lb	.06½–......	.06½–......	.06½–......
Red, dry, sck., lb	.07¾–......	.07½–......	.0735–......
Lead acetate, white crys., bbl., lb	.11 – .12	.11 – .12	.10 – .11
Lead arsenate, powd., bag, lb	.08½– .11	.10 – .10½	.11 – .11½
Lime, chem., bulk, ton	8.50 –......	8.50 –......	8.50 –......
Litharge, pwd., csk., lb	.06¾–......	.06½–......	.0635–......
Lithophone, bags, lb	.036– .04	.036– .04	.04¼– .05
Magnesium carb., tech., bags, lb	.06¼– .06½	.06¼– .06½	.06 – .06½

The accompanying prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to March 13

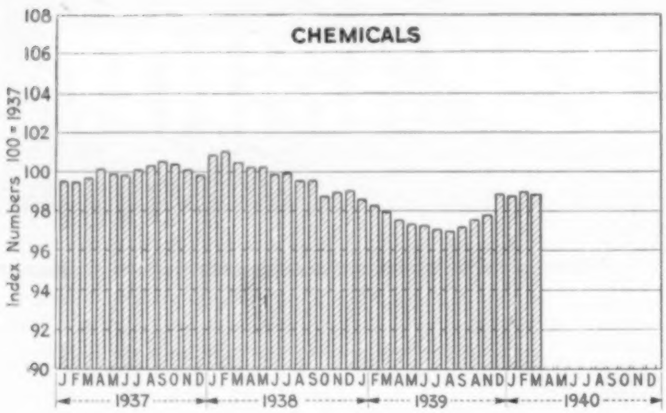
Current PRICES

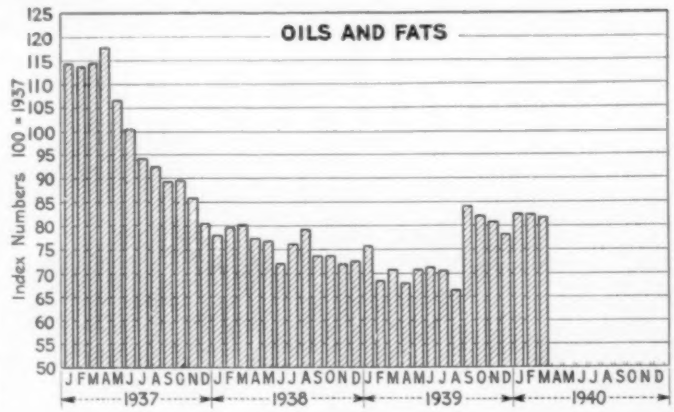
	Current Price	Last Month	Last Year
Methanol, 95%, tanks, gal	.31 –......	.31 –......	.31 –......
97%, tanks, gal	.32 –......	.32 –......	.32 –......
Synthetic, tanks, gal	.33 –......	.33 –......	.33 –......
Nickel salt, double, bbl., lb	.13 – .13½	.13 – .13½	.13 – .13½
Orange mineral, csk., lb	.10¼–......	.10¼–......	.10¼–......
Phosphorus, red, cases, lb	.40 – .42	.40 – .42	.40 – .42
Yellow, cases, lb	.18 – .25	.18 – .25	.18 – .25
Potassium bichromate, casks, lb	.08½– .09	.08½– .09	.08½– .09
Carbonate, 80–85%, calc. csk., lb	.06¼– .07	.06¼– .07	.06¼– .07
Chlorate, powd., lb	.10 – .12	.10 – .12	.09½–......
Hydroxide(c'stic potash) dr., lb	.07 – .07½	.07 – .07½	.07 – .07½
Muriate, 80% bgs., unit	.53½–......	.53½–......	.53½–......
Nitrate, bbl., lb	.05½– .06	.05½– .06	.05½– .06
Permanganate, drums, lb	.18½– .19	.18½– .19	.18½– .19
Prussiate, yellow, casks, lb	.15 – .16	.15 – .16	.14 – .15
Sal ammoniac, white, casks, lb	.05½– .06	.05½– .06	.05 – .05½
Salsoda, bbl., cwt	1.00 – 1.05	1.00 – 1.05	1.00 – 1.05
Salt cake, bulk, ton	23.00 –......	23.00 –......	13.00 –15.00
Soda ash, light, 58%, bags, contract, cwt	1.05 –......	1.05 –......	1.05 –......
Dense, bags, cwt	1.10 –......	1.10 –......	1.10 –......
Soda, caustic, 76%, solid, drums, cwt	2.30 – 3.00	2.30 – 3.00	2.30 – 3.00
Acetate, works, bbl., lb	.04 – .05	.04 – .05	.04 – .05
Bicarbonate, bbl., cwt	1.70 – 2.00	1.70 – 2.00	1.70 – 2.00
Bichromate, casks, lb	.06¾– .07	.06¾– .07	.06¾– .07
Bisulphate, bulk, ton	15.00 –16.00	15.00 –16.00	15.00 –16.00
Bisulphite, bbl., lb	.03½– .04	.03½– .04	.03½– .04
Chlorate, kegs, lb	.06¼– .06½	.06¼– .06½	.06¼– .06½
Cyanide, cases, dom., lb	.14 – .15	.14 – .15	.14 – .15
Fluoride, bbl., lb	.07½– .08	.07½– .08	.07½– .08
Hyposulphite, bbl., cwt	2.40 – 2.50	2.40 – 2.50	2.40 – 2.50
Metasilicate, bbl., cwt	2.35 – 2.40	2.35 – 2.40	2.20 – 3.20
Nitrate, bulk, cwt	1.45 –......	1.45 –......	1.45 –......
Nitrite, casks, lb	.06¾– .07	.06¾– .07	.06¾– .07
Phosphate, tribasic, bags, lb	2.25 –......	2.25 –......	1.85 –......
Prussiate, yel. drums, lb	.10½– .11	.10½– .11	.09½– .10
Silicate (40° dr.) wks., cwt	.80 – .85	.80 – .85	.80 – .85
Sulphide, fused, 60–62%, dr., lb	.02¾– .03½	.02¾– .03	.02¾– .03
Sulphite, crys., bbl., lb	.02¼– .02½	.02¼– .02½	.02¼– .02½
Sulphur, crude at mine, bulk, ton	16.00 –......	16.00 –......	18.00 –......
Chloride, dr., lb	.03 – .04	.03 – .04	.03 – .04
Dioxide, cyl., lb	.07 – .08	.07 – .08	.07 – .07½
Flour, bag, cwt	1.60 – 3.00	1.60 – 3.00	1.60 – 3.00
Tin Oxide, bbl., lb	.52 –......	.52 –......	.50 –......
Crystals, bbl., lb	.37 –......	.36 –......	.36 –......
Zinc chloride, gran., bbl., lb	.05 – .06	.05 – .06	.05 – .06
Carbonate, bbl., lb	.14 – .15	.14 – .15	.14 – .15
Cyanide, dr., lb	.33 – .35	.33 – .35	.33 – .35
Dust, bbl., lb	.07¾–......	.07¾–......	.06½–......
Zinc oxide, lead free, bag., lb	.06½–......	.06½–......	.06½–......
5% lead sulphate, bags, lb	.06½–......	.06½–......	.06½–......
Sulphate, bbl., cwt	2.75 – 3.00	2.75 – 3.00	2.75 – 3.00

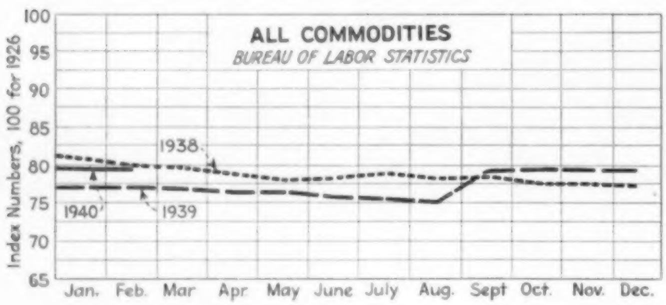
OILS AND FATS

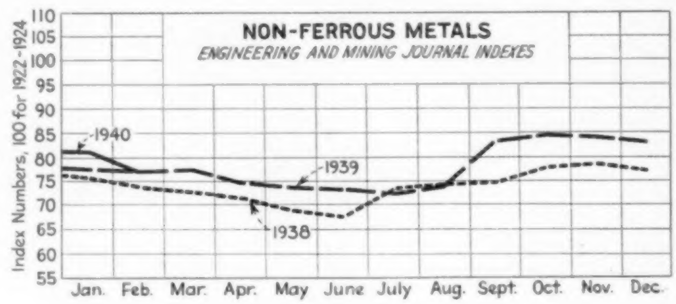
	Current Price	Last Month	Last Year
Castor oil, 3 bbl., lb	$0.11¼–$0.12	$0.11¼–$0.12	$0.09½–$0.10
Chinawood oil, bbl., lb	.27 –......	.27 –......	.14½–......
Coconut oil, Ceylon, tank, N. Y., lb	.03¼–......	.03¼–......	.03¼–......
Corn oil crude, tanks (f. o. b. mill), lb	.06½–......	.06 –......	.05¼–......
Cottonseed oil, crude (f. o. b. mill), tanks, lb	.06¼–......	.06 –......	.05¼–......
Linseed oil, raw car lots, bbl., lb	.106–......	.103–......	.088–......
Palm, casks, lb	.04¾–......	.05¼–......	.03¼–......
Peanut oil, crude, tanks (mill), lb	.06¼–......	.06¼–......	.05¾–......
Rapeseed oil, refined, bbl., gal	1.00 –......	1.00 –......	.80 –......
Soya bean, tank, lb	.05½–......	.05½–......	.05¼–......
Sulphur (olive foots), bbl., lb	.08 –......	.08 –......	.07 –......
Cod, Newfoundland, bbl., gal	nom.	nom.	.38 –......
Menhaden, light pressed, bbl., lb	.075–......	.075–......	.07 –......
Crude, tanks (f. o. b. factory), gal	.36 –......	.36 –......	.30 –......
Grease, yellow, loose, lb	.05 –......	.05 –......	.04¾–......
Oleo stearine, lb	.06½–......	.06½–......	.06¼–......
Oleo oil, No. 1	.07 –......	.07½–......	.07¼–......
Red oil, distilled, d.p. bbl., lb	.09 –......	.09 –......	.07½–......
Tallow extra, loose, lb	.05½–......	.05½–......	.05¼–......

Chem. & Met.'s Weighted Price Indexes









COAL-TAR PRODUCTS

	Current Price	Last Month	Last Year
Alpha-napthol, crude bbl., lb	$0.52 -$0.55	$0.52 -$0.55	$0.52 -$0.55
Alpha-naphthylamine, bbl., lb	.32 - .34	.32 - .34	.32 - .34
Aniline oil, drums, extra, lb	.15 - .16	.15 - .16	.15 - .16
Aniline, salts, bbl., lb	.22 - .24	.22 - .24	.22 - .24
Benzaldehyde, U.S.P., dr., lb	.85 - .95	.85 - .95	.85 - .95
Benzidine base, bbl., lb	.70 - .75	.70 - .75	.70 - .75
Benzoic acid, U.S.P., kgs., lb	.54 - .56	.54 - .56	.54 - .56
Benzyl chloride, tech., dr., lb	.23 - .25	.23 - .25	.23 - .25
Benzol, 90%, tanks, works, gal	.16 -......	.16 - .18	.16 - .18
Beta-napthol, tech., drums, lb	.23 - .24	.23 - .24	.23 - .24
Cresol, U.S.P., dr., lb	.09½- .10	.09½- .10	.10 - .11
Cresylic acid, dr., wks., gal	.58 - .60	.58 - .60	.69 - .71
Diethylaniline, dr., lb	.40 - .45	.40 - .45	.40 - .45
Dinitrophenol, bbl., lb	.23 - .25	.23 - .25	.23 - .25
Dinitrotoluen, bbl., lb	.15½- .16	.15½- .16	.15 - .16
Dip oil, 15%, dr., gal	.23 - .25	.23 - .25	.23 - .25
Diphenylamine, bbl., lb	.32 - .36	.32 - .26	.32 - .36
H-acid, bbl., lb	.50 - .55	.50 - .55	.50 - .55
Naphthalene, flake, bbl., lb	.06¾- .07	.06¾- .07	.05¾- .06
Nitrobenzene, dr., lb	.08 - .09	.08 - .09	.08 - .09
Para-nitraniline, bbl., lb	.47 - .49	.47 - .49	.47 - .49
Phenol, U.S.P., drums, lb	.13 -......	.13 -......	.14½-......
Picric acid, bbl., lb	.35 - .40	.35 - .40	.35 - .40
Pyridine, dr., gal	1.70 - 1.80	1.70 - 1.80	1.55 - 1.60
Resorcinal, tech., kegs, lb	.75 - .80	.75 - .80	.75 - .80
Salicylic acid, tech., bbl., lb	.33 - .40	.33 - .40	.33 - .40
Solvent naptha, w.w., tanks, gal	.27 -......	.27 -......	.26 -......
Tolidine, bbl., lb	.86 - .88	.86 - .88	.86 - .88
Toluene, drums, works, gal	.30 -......	.30 -......	.27 -......
Xylene, com, tanks, gal	.27 -......	.27 -......	.26 -......

MISCELLANEOUS

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl., ton	$22.00-$25.00	$22.00-$25.00	$22.00-$25.00
Casein, tech., bbl., lb	.10 - .14	.10½- .14	.07½- .11
China clay, dom., f.o.b. mine, ton	8.00 -20.00	8.00 -20.00	8.00 -20.00
Dry colors			
Carbon gas, black (wks.), lb	.02¾- .30	.02¾- .30	.02½- .30
Prussian blue, bbl., lb	.36 - .37	.36 - .37	.36 - .37
Ultramarine blue, bbl., lb	.11 - .26	.11 - .26	.10 - .26
Chrome green, bbl., lb	.21½- .30	.21½- .30	.21 - .27
Carmine red, tins, lb	4.85 - 5.00	4.85 - 5.00	4.00 - 4.40
Para toner, lb	.75 - .80	.75 - .80	.75 - .80
Vermilion, English, bbl., lb	2.85 - 2.90	2.45 - 2.60	1.58 - 1.60
Chrome yellow, C.P., bbl., lb	.14½- .15½	.14½- .15½	.14½- .15½
Feldspar, No. 1 (f.o.b. N.C.), ton	6.50 - 7.50	6.50 - 7.50	6.50 - 7.50
Graphite, Ceylon, lump, bbl., lb	.06 - .06½	.06 - .06½	.06 - .06½
Gum copal Congo, bags, lb	.08 - .30	.08 - .30	.06 - .30
Manila, bags, lb	.09 - .15	.09 - .14	.09 - .14
Damar, Batavia, cases, lb	.10 - .22	.10 - .20	.08 - .24
Kauri, cases, lb	.18 - .60	.18 - .60	.18½- .60
Kieselguhr (f.o.b. N.Y.), ton	50.00 -55.00	50.00 -55.00	50.00 -55.00
Magnesite, calc, ton	50.00 -......	50.00 -......	50.00 -......
Pumice stone, lump, bbl., lb	.05 - .07	.05 - .08	.05 - .07
Imported, casks, lb	.03 - .04	.03 - .04	.03 - .04
Rosin, H., bbl	6.95 -......	6.80 -......	7.0) -......
Turpentine, gal	.36½-......	.41 -......	.34 -......
Shellac, orange, fine, bags, lb	.28 -......	.28 -......	.20 -......
Bleached, bonedry, bags, lb	.25 -......	.25 -......	.19 -......
T. N. Bags, lb	.16½-......	.19 -......	.10½-......
Soapstone (f.o.b. Vt.), bags, ton	10.00 -12.00	10.00 -12.00	10.00 -12.00
Talc. 200 mesh (f.o.b. Vt.), ton	8.00 - 8.50	8.00 - 8.50	8.00 - 8.50
300 mesh (f.o.b. Ga.), ton	7.50 -10.00	7.50 -10.00	7.50 -11.00
225 mesh (f.o.b. N.Y.), ton	13.75 -......	13.75 -......	13.75 -......

INDUSTRIAL NOTES

WORTHINGTON PUMP AND MACHINERY CORP., Harrison, N. J., announces that Charles E. Wilson, vice-president since 1934 in charge of Pacific Coast operations, has moved to the home office where he will direct sales of the Carbondale Division.

AMERICAN CYNAMID CO., New York, has made an important addition to the power plant of the Calco Chemical Division at Bound Brook, N. J.

TEAL CHEMICAL CO., Tarrent City, Ala., is erecting a new plant for the manufacture of calcium carbide.

FOOTE BROS. GEAR AND MACHINE CO., Chicago, has elected William A. Barr president to succeed F. H. Fowler who resigned last November.

THE RELIANCE ELECTRIC & ENGINEERING CO., Cleveland, has transferred George E. Law from the main office to Chicago where he is acting in capacity of sales engineer.

THE DAVIDSON CHEMICAL CORP., Baltimore, has made arrangements whereby The C. M. Kemp Mfg. Co. of Baltimore will manufacture and sell a complete line of silica gel drying units for industrial dehydration.

FOOTE MINERAL CO., Philadelphia, has completed a modern, three-story fireproof grinding unit and warehouse at Queen St. and Mermaid Lane.

THE FALK CORP., Milwaukee, announces that Herman W. Falk, founder of the company and president since its inception, has become chairman of the board and is succeeded as president by Harold S. Falk.

INTERNATIONAL-STACY CORP., Cleveland, has elected Oscar M. Havekotte president to succeed the late Lewis J. Brown.

THE INSECTICIDE CORP. OF AMERICA, Medina, N. Y., recently formed, plans to take over property of the former New York Insecticide Co., and to consolidate the interests of the Miller Chemical Co., of Baltimore and the Central Chemical Co. of Hagerstown, Md.

RUMFORD CHEMICAL WORKS, Rumford, R. I., has appointed Raymond E. Gaylord as general sales manager.

THE HYDRAULIC PRESS MFG. CO., Mount Gilead, Ohio, has moved its New York office to 233 Broadway.

E. I. DUPONT DE NEMOURS & CO., Wilmington, will construct a three-story brick and tile laboratory for research on insecticides and fungicides for the Grasselli Pest Control Research Section.

KOPPERS CO., Pittsburgh, Engineering and Construction Division, has opened a branch office at Tulsa, Okla., with W. A. Leech, Jr. in charge.

New CONSTRUCTION

	Current Projects		Cumulative 1940	
	Proposed Work	Contracts	Proposed Work	Contracts
New England	$40,000	$40,000	$40,000	$80,000
Middle Atlantic	2,650,000	600,000	7,035,000	917,000
South	5,425,000	2,000,000	9,955,000	10,825,000
Middle West	2,700,000	570,000	6,635,000	1,220,000
West of Mississippi	2,600,000	1,465,000	7,955,000	4,051,000
Far West	75,000	500,000	905,000	3,700,000
Canada	245,000	45,000	1,450,000	555,000
Total	$13,735,000	$5,220,000	$33,975,000	$21,348,000

PROPOSED WORK

Acid Factory—Read Phosphate Co., 54th Ave., N., Nashville, Tenn., plans to rebuild its acid factory at West Nashville recently destroyed by fire. Estimated cost $75,000.

Alcohol Plant—Power Alcohol Cooperative Assn., c/o W. H. Schwiebert, Pres., Victor, Ia., plans to construct a plant for the manufacture of alcohol from corn for use in gasoline blending. Estimated cost $200,000.

Carbon Factory—Stackpole Carbon Co., St. Marys, Pa., plans to construct three 1 story additions to its factory. $60,000.

Celanese Factory—Canadian Celanese, Ltd., J. P. Wright, Purch. Agt., Drummondville, Que., Can., plans to construct additions to its factory. Estimated cost $125,000.

Cement Plant—Lehigh Portland Cement Co., Allentown, Pa., plans improvements to its plant. Cost will exceed $100,000.

Chemical Plant—Dow Chemical Co., Midland, Mich., has purchased approximately 800 acres of land with 3 mi. of harbor frontage at Freeport, Tex., and plans to proceed with construction of plant as soon as contracts now pending can be satisfactorily concluded.

Clay Processing Plant—J. P. Jones, Bossier, La., and W. A. Frazier, Minden, La., plan to construct a clay milling and processing plant about 2 mi. north of Clarksburg, Tenn. Estimated cost $100,000.

Fertilizer Plant—Vitagen Corp., 245 Woodward Bldg., Washington, D. C., plans to construct and equip a mechanized fertilizer plant on the property of the Organo Corp., a subsidiary, about 3 mi. south of Orlando, Fla. V. C. Babcock, Organo Corp., Orlando, Engr. Estimated cost $250,000.

Gas Plant—American Liquid Gas Corp., 650 South Grand Ave., Los Angeles, Calif., plans to construct a Butane gas plant at Nampa, Idaho. Estimated cost $75,000.

Gas Pipe Line—Kansas Pipe Line & Gas Co., Manhattan, Kan., plans to construct 1,000 mi. 10 in. natural gas pipe line from fields in Texas Panhandle to Northern Minnesota, electrically welded, capacity 120,000,000 cu. ft. daily. Estimated cost $33,000,000.

Glass Factory—Brockway Glass Co., R. L. Warren, Pres., Beadle Bldg., Brockway, Pa., plans to construct a 1 and 3 story, 110x632 ft. glass factory. Frazier Simplex, Inc., 436 East Beau St., Washington, Pa., Engr. Estimated cost $500,000.

Glass Factory—Owens-Illinois Glass Co., Ohio Bldg., Toledo, O., and Alton, Ill., has acquired a 52 acre site at Waco, Tex., and plans to construct and equip a glass factory. R. A. Cosh, c/o General Engineering Dept., Alton, Ill., designing engineer. Estimated cost $600,000.

Oil Refinery—Abasand Oils Ltd., P.O. Box 156, Edmonton, Alta., Can., is having plans prepared for extensions to its refinery at McMurray, Alta., Can. $50,000.

Oil Refinery—Owner c/o Philip Ney, 421 Lisgar St., Ottawa, Ont., Can., plans to construct an oil refinery about 44 mi. from McMurray, Alta. $70,000.

Oil Refinery—Socony-Vacuum Oil Co., Inc., 230 Park Ave., New York, N. Y., and Magnolia Petroleum Co., Beaumont, Tex., plans to construct and equip a reforming and thermal polymerization unit in the area outside the city limits of Beaumont, to provide quality improving process in manufacture of high grade gasoline. Estimated cost $250,000.

Oil Refinery—Taylor Refinery Co., J. F. Whitehurst, Mgr., Corpus Christi, Tex., plans to construct a 1 story oil refinery at Snyder, Tex. $50,000.

Oil Refinery—Wisconsin Oil Refining Co., D. E. Foster, Security Natl. Bank Bldg., Sheboygan, Wis., plans to construct an oil refinery at Wilson, Wis. Estimated cost between $700,000 and 750,000.

Pharmaceutical Manufacturing Plant—Andrew Jergens Co., 2525 Spring Grove Ave., Cincinnati, O., will soon award the contract for a plant on Mill St., Belleville, N. J. Tietig & Lee, 34 West 6th St., Cincinnati, Archts. Estimated cost $1,000,000.

Polish Factory—J. A. Wright & Co., J. P. Wright, Pres., 30 Emerald St., Keene, N. H., is having plans prepared by Adden, Parker, Clinch & Crimp, Archts., 177 State St., Boston, Mass., for a 2 story factory for the manufacture of silver polish. Cost including equipment $40,000.

Processing Plant—Woburn Industries, c/o M. D. L. Van Over, Pres., Harrison, N. J., and Brownsville, Tex., plans to construct and equip a plant at Brownsville, to handle castor beans and byproducts and process same for the manufacutre of insecticides and fungicides from the leaves and fertilizer from the wastes. Estimated cost $500,000.

Rayon Mill—American Viscose Corp., Marcus Hook, Pa., contemplates the construction of a rayon mill somewhere in the South East. Site has not yet been selected. Estimated cost $5,000,000.

Rayon Mill—Industrial Rayon Corp., H. S. Rivitz, Pres., West 98th St. and Walford Ave., Cleveland, O., is having sketches prepared by Wilbur Watson & Assoc., Archts., 4614 Prospect Ave., Cleveland, for a 1 and 2 story addition to its mill at Painesville, O. Estimated cost $2,000,000.

Rubber Factory—Hewitt Rubber Co., Kensington Ave., Buffalo, N. Y., is having plans prepared by H. E. Plummer & Assoc., Archts., 775 Main St., Buffalo, N. Y., for an addition to its plant to be known as Section "B". $50,000.

Soap Factory—Proctor & Gamble, Inc., Gwynne Bldg., Cincinnati, O., and 1226 Loomis St., Dallas, Tex., plans to construct a soap manufacturing plant at Dallas. Estimated cost $1,000,00.

Synthetic Rubber Factory—Standard Oil Co. of New Jersey, 30 Rockefeller Plaza, New York, N. Y., plans to construct a plant for the manufacture of synthetic rubber. Site has not been selected yet. Estimated cost between $1,000,000 and $1,200,000.

CONTRACTS AWARDED

Carbon Black Plant—J. M. Huber Corp., Borger, Tex., has awarded the contract for a factory to Koppers Co., Koppers Bldg., Pittsburgh, Pa. $190,000.

Celluloid Factory—Celluloid Corp., 290 Ferry St., Newark, N. J., has awarded the contract for a 1 story factory to Walter Kidde Constructors, Inc., 140 Cedar St., New York, N. Y.

Cement Plant—Universal Atlas Cement Co., McGregor Rd., Waco, Tex., has awarded the contract for a cement plant to McClellan, Brown & McClellan, 115 North 17th St., Waco. $70,000.

Chemical Plant—B. F. Goodrich Co., 500 South Main St., Akron, O., has awarded the contract for an addition to Mill No. 3, West Emerling Ave. Ext., west of South Main St., to be used for the production of chemicals, to Indiana Engineering & Construction Co., 109 North Union St., Akron. $70,000.

Chemical Factory—Walker Chemical Corp., 171Westminster St., Providence, R. I., will construct a factory at Wood River Junction, Carolina, R. I. Work will be done by owner. $40,000.

Insulation Board Plant—Flintkote Co., 50 West 50th St., New York, N. Y., has awarded the contract for an insulation board plant at Meridian, Miss., to Rust Engineering Co., Martin Bldg., Birmingham, Ala. Estimated cost $2,000,000.

Oil Refinery—Conewango Refining Co., Market St. Ext., Warren, Pa., will improve and enlarge its oil refinery and processing plant at Warren. Work will be done by owner under separate contracts. Cost including equipment will exced $40,000.

Oil Refinery—Wood River Oil & Refining Co., Hartford, Ill., has awarded the contract for a crude oil refinery to Winkler-Koch Engineering Co., Wichita, Kan. Cost will exced $500,000.

Paper Mill—St. Regis Paper Co., 230 Park Ave., New York, N. Y., has awarded the contract for a 2 story mill at Deferiet, N. Y., to Enos Construction Co., Herkimer, N. Y. Cost will exceed $40,000.

Pharmaceutical Manufacturing Plant—Ciba Pharmaceutical Products, Inc., Lafayette Park, Summit, N. J., has awarded the contract for 2 additions to its plant to Walter Kidde Constructors, Inc., 140 Cedar St., New York, N. Y.

Powder Factory—Illinois Powder Co., 124 North 4th St., St. Louis, Mo., will construct plant for the manufacturer of dynamites and powder explosives at the mouth of Spanish Fork Canyon, near Spanish Fork, Utah. Work will be done by day labor. Estimated cost $500,000.

Recycling Plant—Gulf Plains Corp., Corpus Christi, Tex., organized by J. J. Sheerin, Milam Bldg., San Antonio, Robert T. Wilson, Amarillo, and Clyde Alexander, Dallas, has awarded the contract for a recycling plant in Agua Dulce Fields in western Neuces Co., near Agua Dulce, to Stearns-Rogers Corp., 1720 California, St., Denver, Colo., at $965,000.

Recycling Plant—Roeser & Pendleton, Mid Continent Bldg., Fort Worth, and Cayuga, Tex., has awarded the contract for a recycling plant in Cayuga Fields near Palestine, Tex., to Stearns-Rogers Corp., 1720 California St., Denver, Colo. $200,000.

Research Laboratory—Powell River Co., Ltd., Powell River, B. C., Can., has awarded the contract for a research laboratory to Stuart Cameron & Co., Ltd., 710 Seymour St., Vancouver, B. C. $45,000.

Rubber Factory—Hewitt Rubber Corp., Kensington Ave., Buffalo, N. Y., has awarded the contract for an addition to its plant to J. W. Cowper Co., Sidway Bldg., Buffalo. $100,000.

Cement Storage Bins—Lone Star Cement Corp., 342 Madison Ave., New York, N. Y., has awarded the contract for storage bins at Hudson, N. Y., to Rust Engineering Co., Clark Bldg., Pittsburgh, Pa. Estimated cost $300,000.

Chemical Warehouse—Monsanto Chemical Co., 1700 South Second St., St. Louis, Mo., has awarded the contract for a 1 story warehouse to Fruin-Conlon Contracting Co., 502 Merchants Laclede Bldg., St. Louis. $40,000.

Chemical Warehouse—Calco Chemical Co., Inc., Bound Brook, N. J., has awarded the contract for a 2 story, 150x720 ft. warehouse to Edmund Stearns Construction Co., Inc., 56 James St., Montclair, N. J.